


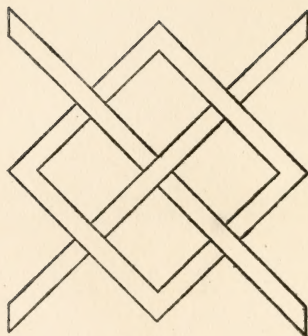


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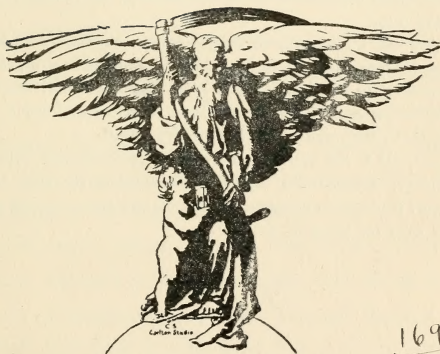
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Angina Pectoris

by


Walter Verdon, F.R.C.S.



169244.
13.2.22.

BAILLIÈRE, TINDALL & COX,
LONDON.

1920.



"When tender spots, which come and go, are found at points of outcrop of intercostal nerves and when rigidity in somatic muscle appears, we recognise the existence of hyper-irritability at segmentary centres; when sensations pathognomonic of globus are ingravescent and merge into agonising pain radiating from thoracic stations, situated in one attack at upper, in others at lower, and yet again in others, at mid sternal regions, we know that these sensations are generated in œsophagus and that they spring from spasm occurring at sectional portions of the muscular tunic of this lengthy tube.

Now, we read the lesson writ large in cardio-graphic records and we learn from the tape, that even in the extremity of anginous pain, the heart may be pursuing the usual quiet tenour of its rhythmic round, unperturbed by disorder in any one of its five Gaskellian functions and wholly unconcerned in the gravity and turmoil of passing events.

The stolidity of the heart startles us, and after repeated sequences of these displays, consciousness awakens gradually to the fact, that, no primary part is played in anginous etiology by this long suspected organ."
—Extract from the diary of Dr. X—.

Introduction.

FOR more than one hundred years, the muscle of the heart, its vessels or its valves, have been looked upon Scheme of enquiry. by writers of note, as the seat of the angina pectoris, nevertheless the particular tissue or function responsible for the seizure remains still under dispute; neither has the introduction of instruments of precision, nor new methods of cardio-graphic record, brought the matter nearer. In numerous instances it has been found that during the very extremity of anginous pain, every essential function of the myo-cardium is working after a normal manner. These considerations prompt us to shift the ground of our enquiry to a hitherto neglected field.

Evidence introduced in the pages of this work points to hyper-irritability of the central nervous system as the predisposing cause of seizures and as the basis of the anginous

Scheme of
enquiry.

habit. It locates the seat of the proximal exciting cause in the muscular tunic of the gastro-œsophageal portion of the alimentary canal, and it regards disturbance of the heart when occurring, as a concurrent symptom of no causal significance. In considering this issue I have tried to keep steadily in mind the other side of the question, and in proof of my thesis I have drawn largely for clinical illustrations from the works of high authorities whose conception of the nature of the complaint differs fundamentally from my own. In this matter, chiefly to Sir Clifford Allbutt, who has searched anginous literature through and through for examples—now stored and arranged in his classic work—I owe a deep debt of gratitude.

H. Walter Verdon.

58 Streatham Hill, S.W.

November, 1920.

Errata.

Page 27 line 27 for influence	<i>read inference</i>
„ 32 „ 11 „ breath	„ breadth
„ 32 „ 19 „ pelvis	„ pelvic
„ 34 „ 14 „ were	„ was
„ 42 „ 14 „ trapezias	„ trapezius
„ 59 „ 10 „ recti-adominis	„ recti-abdominis
„ 61 „ 13 „ embarrassed	„ embarrassed
„ 61 „ 26 „ single	„ singular
„ 63 „ 12 „ sine doloris	„ sine dolore
„ 73 „ 40 „ stimululus	„ stimulus
„ 86 „ 2 „ anginous	„ angina
„ 92 „ 6 „ brodycardia	„ bradycardia
„ 96 „ 24 „ aniginal	„ anginal
„ 98 „ 10 „ bilaterial	„ bilateral
„ 99 „ 5 „ unbilical	„ umbilical
„ 110 „ 5 „ functonal	„ functional
„ 111 „ 15 „ Hyperthesis	„ Hypothesis
„ 111 „ 21 „ syptoms	„ symptoms
„ 169 „ 22 „ contemporaneously	„ contemporaneously
„ 176 „ 6 „ alright	„ all right
„ 176 „ 26 „ sendentary	„ sedentary
„ 196 „ 21 „ augumented	„ augmented
„ 197 „ 22 „ bifurca	„ bifurcation
„ 211 „ 26 „ exercises	„ exercise
„ 212 „ 5 „ organising	„ agonising
„ 213 „ 26 „ syptoms	„ symptoms
„ 237 „ 9 „ conjunction	„ conjunctiva
„ 239 „ 4 „ cadiac	„ cardiac
„ 245 „ 22 „ vicero	„ viscero
„ 246 „ 1 „ vertibra	„ vertebra
„ 246 „ 20 „ nipples	„ nipple
„ 252 „ 2 „ ye hear	„ thou hearest
„ 252 „ 3 „ or	„ and
„ 260 „ 11 „ perilious	„ perilous
„ 267 „ 3 „ gasses	„ gases
„ 268 „ 22 „ remedied	„ remedial
„ 269 „ 16 „ excercise	„ exercise
„ 287 „ 12 „ tend	„ tends
„ 301 „ 1 „ receptive	„ protective
„ 324 „ 23 „ soepia	„ sepia
„ 326 „ 24 „ fances	„ fauces
„ 329 „ 13 „ looses	„ loses
„ 331 „ 22 „ stumuli	„ stimuli
„ 343 „ 6 „ view	„ views
„ 354 „ 3 „ sphinchter	„ sphincter
„ 373 „ 7 „ enter	„ enters
„ 373 „ 20 „ carotoid	„ carotid
„ 374 „ 8 „ carotoid	„ carotid



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Part I. Symptomatology.

Chapter I.

General Characteristics of Symptomatology.

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Section I. *Description of Seizures induced through Walking.*

IN the summer of 1907 I made it a practice to accompany Dr. X. on his walks and to observe paroxysms as they occurred, and from time to time I listened to accounts given to me, relating to subjective sensations felt by him, and thus learned much from him appertaining to the symptomatology of seizures brought on by walking.

For some years, before the anginous habit was contracted, or perhaps it would be more correct to say, while it was being acquired, discomfortable sensations of pressure at the upper

§1Description
of seizures
induced
through
walking.

part of the chest were noticed by Dr. X., and attributed by him to an accumulation of gas in the stomach. These sensations came on soon after setting out for a walk, particularly if up-hill, and after eating. They always vanished instantly when gas was thrown from the chest. Occasionally, in the middle of the night, oppression at the chest awakened him from sleep, and made him sit up in bed, or get up and pace the room. After upheaval of gas the sensation left him, and he returned to bed and slept. At certain seasons, for weeks and months together he was not troubled with gas. Dr. X. was a small eater, and seldom indulged appetite in food stuffs not simple and wholesome.

Dr. X.'s age was 59. With the exception of a gassy stomach, a heritage from his twenties, his organs were robust. For many years previous to the advent of angina, he had taken long morning and evening walks, to induce gas to break away from his chest. Of late, desire to expel gas was accompanied by discomfortable retro-sternal and retro-costal sensations of pressure, and fulness merging into pain, which grew worse as long as walking was continued. But whether he halted or not, if gas were expelled in quantity, discomfortable sensations vanished. If the expulsion of gas were not exhaustive, discomfort returned soon after walking was resumed.* Discomfortable sensations were more frequent and severe in

* I have examined many anginous and non-anginous subjects of gassy stomach under rontgen rays and have noted that in these cases it is usual to find the stomach below the site of the hour glass constriction, small and exceedingly contractile; the bismuth meal leaving the organ soon after it has entered it. Invariably these subjects are persuaded that the stomach is dilated.

cold weather than in mild, in windy weather than in calm, in the atmosphere of town rather than in that of the east coast. Even when weather is warm and calm, and for no valid reason known, seasons of intensivity of symptoms lasting several days intrude upon a quiescent season. At such times fluids taken, even moderately hot, cause uncomfortable sensations at the epigastrium.

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of seizures
induced
through
walking.

To describe seizures with precision:—At an early stage of the walk, after a few hundred yards had been covered, a sensation of fulness and pressure at the chest, accompanied by a desire to eructate, was felt. The sensation was not superficial, nor sternal, nor costal, it was retro-sternal, retro-costal, and occasionally quite deep. Sometimes it was felt at the upper third of the chest, sometimes at the lower, and sometimes at the mid-third. It was never felt above the synchondrosis and seldom below the xiphoid cartilage. Occasionally it inclined to the right of the sternum, but far more frequently to the left side. Not always, but not infrequently, this sensation was attended by a feeling as if a bolus of food or a ball of gas were lodged in the gullet; a symptom which, when occurring in the hysterical subject, is described under the name of globus.

If eructation were difficult and if the quantity of gas expelled were small, slight relief followed. If large and exhaustive, relief was instant and complete, the patient then finding himself able to pursue his journey without further molestation. Voluminous and exhaustive eructations, however, were not of frequent occurrence. Usually an attenuated escape

§1Description
of seizures
induced
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walking.

of gas followed each successive retching, and the fulness at the chest, the pressure, the discomfort, the feeling of a lodgment in the gullet, and the desire to eructate, remained unabated, until the patient had ceased from walking.

Discomfortable sensations on walking had been in existence for many years before actual pain was felt, and referred to the substance of the thoracic wall. Now discomfort merges into pain which is felt just below the plane of the synchondrosis, on one or at either side, while discomfortable sensations of fulness and pressure still continue and are referred to the whole chest cavity. Their intensity increases, and they are described as crushing and bursting sensations. Distinct from these, discomfortable feelings of constriction or fixation of the thoracic wall, are noticed sensations such as might be expected to result from rigidity of intercostal muscles. As the walk is still further continued, the area of pain extends. Painful spots are felt at anterior folds of the axilla, and isolated areas of pain, situated at the inner aspect of either one or both arms below axillæ, creep into consciousness. Pain may also affect scapulæ, neck, and maxillæ, and finally, chest, neck, shoulders, and arms are seething with pain currents. During one of Dr. X.'s seizures, which came on while he was walking round my garden, I mapped on the skin the limitations of areas where superficial pain was felt, which corresponded exactly with points of outcrop and distribution of peripheral terminals of intercostal nerves.

When the attack is prolonged for a sufficient time to test the limits of the patient's endurance, other symptoms

come under notice. The features are pinched and grey, and drops of perspiration stand on the forehead. His eyes are set in a direction straight before him. Sometimes they are suffused with tears, which gather between the lids and ripple down the cheeks. Sight is misty and dim ; Hearing is distant. Will power suffers impairment, and the patient is careless of his surroundings. He walks through mud and pools of water, although the road a few steps on either side is dry. He reels from side to side, like a drunken man, and clings to any near object for support ; yet I have never known him fall. From replies to questions put immediately after the attack is over, I gather that pain is attended by an overwhelming sense of weakness.

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of seizures
induced
through
walking.

Circulatory symptoms usually follow soon after the first feelings of thoracic fulness have been noticed. The pulse at the wrist, which is full and strong when the patient sets out to walk, is now small and feeble. The artery is sometimes constricted, hard, and thready ; at others it is small, soft and compressible. The pulse rate may either be normal, increased in numbers of beats, or slow : but differs in different attacks. The rhythm, generally regular, is occasionally uneven, and then its tenour is broken by numerous extra-systoles or by inhibitory pauses. The shrunken fingers, the coldness and the pallor of the skin, indicate a shortage in ventricular output and an attenuation of the peripheral stream.

The form of cardiac pulsation resembles that observed just before vomiting attacks occur. I have sometimes been astonished upon observing, at the same moment, strong and

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of seizures
induced
through
walking.

tumultuous action of the heart under a chest wall quivering responsively to each beat, associated with a soft, small and quick radial pulse. Moreover, these cardiac conditions are in evidence when the entire length of the artery of the upper extremity from the wrist to the axilla, as far as palpation can determine its state, is compressible and without constriction. On fifteen occasions I have taken readings of arterial pressure while symptoms of the seizures were still apparent, and I have noticed the index to mark a lower level of mercury than that which obtains in inter-paroxysmal periods. This is the usual rule, nevertheless exceptionally high elevations are not infrequently recorded.

Conditions of venous circulation are worthy of note. When the patient is at rest, veins at the dorsum of the hands and arms are large and full; but during seizures they are shrunken and empty. I have sometimes seen them, at times of paroxysm, looking no larger than threads, lying beneath the level of the skin, at the fundus of sulci, which recently contained swollen veins.

From these observations it is to be noted that during attacks, venous and arterial pressure is commonly below the standard of that of inter-paroxysmal periods. As, in the predromal stage of vomiting, the bulk of the blood stream is withdrawn from the peripheral system of vessels, and lodged in dilated arterioles, capillaries, and venous lacunæ of the splanchnic system of vessels.

A symptom, not constant, but sufficiently frequent in occurrence and peculiar in character to invite notice, is that

of salivary outpour. The secretion is of light specific gravity, a fact indicating a vaso-dilatatory source. A quantity of saliva, estimated at a cupful, fills the mouth, overflows, and finds exit from corners of the lips. When the patient is halting, it pours down from the lips, and collects in a little pool on the pavement. It is sub-maxillary glandular secretion. It is neither retched up nor coughed up, but comes into the mouth "on its own." Once I examined the mouth of a patient during the outpour. Wharton's ducts were spirting saliva.

Another allied phenomenon, also peculiar in character, is leakage of urine from the bladder. When distress is great involuntary micturition occurs.

Attacks incited by walking seldom attain violent proportions, since their control rests with the sufferer. When he stops walking, symptoms soon vanish. Far different is the case with attacks coming on during periods of quiescence, one of which, occurring in the experience of Dr. X., I am about to relate in his own words. In attacks of this latter type the most restful pose brings no relief.

*

*

*

Section 2. *Typical Examples of Seizures occurring at Times of Rest.*

§ 2 Examples of seizures occurring at times of rest.

ON the morning of 7th March, 1908, while reading the daily paper after a breakfast consisting of a rasher of bacon, a few pieces of dried toast and a cupful of coffee, I became conscious of a dull, aching pain at the chest. Afterwards, and for a few seconds only, did my mind continue centred in the news. For pain, at first felt in the mid line beneath the upper part of the sternum, was now extending upwards to the throat, finally to reach the molar region of the jaws, backwards towards the scapulæ and laterally to axillæ, elbows and wrists. Moreover every moment it was increasing in intensity.

The most extreme manifestation was focussed, and could be located, with some degree of exactitude, in the region lying behind the *manubrio-gladiolar synchondrosis*, while painful sensations of lesser magnitude continually radiated from this centre towards the back, neck and arms. Pain did not extend below the plane of the diaphragm, neither was it accompanied by faintness, sickness, nor embarrassment of breathing. The pulse was irregular, its rate was rapid enough to be beyond my powers of computation. The radial artery, usually full and strong, felt small and thread-like. The skin was wet with perspiration.

It is said that persons stricken by angina pectoris are distressed with forebodings of impending death. I am not conscious of having entertained any apprehensions of this character. My mind was clear, and capable of concentrated thought. I considered the situation for a few seconds, in expectation that the symptoms would pass off, but pain gathering strength rather than abating, I determined that something must be done quickly to obtain relief from my intolerable sufferings. At length I wrote a prescription for nitrite of amyl, and sent it by messenger to a neighbouring chemist.

§ 2 Examples of seizures occurring at times of rest

The effort attendant upon this action greatly aggravated my sufferings. Neck and molar pain was intensified. Vision became affected. Objects seen at a distance across the room seemed to stand in a dark field, surrounded by mist, which rolled in eddies from centre towards circumference.

I had been in extreme pain for twenty-five minutes when the messenger returned, bringing with him a supply of nitrite of amyl capsules. Taking one, I crushed it, and inhaled the vapour. Immediately I felt relief, which first reached the jaws, neck and arms, and afterwards the chest. A sore feeling still remained in the substernal region, which was removed by inhalation of fumes from a second capsule. Fifteen minutes later I was attending to the requirements of patients waiting to see me, and, except from some shakiness of the limbs, feeling no worse for my recent experience.

A second attack came on a few days afterwards in the early morning. Pain in the substernal region awoke me from

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of seizures
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times of rest.

sleep, and, after the lapse of a few minutes, involved the whole chest, the neck and the arms. Pain was of the same character as that of the previous attack, and as rapidly left me after I had inhaled a few breaths of nitrite of amyl.

Including in the count, seizures already described, I have suffered from five definite anginal attacks, all of which occurred during the months of March, April and May, 1908.

For fifteen months before the date of the first attack of this series, I had found myself unable to walk far on rising ground without feeling discomfort and pain in the upper part of the chest, which seemed to be associated always in some manner or other with disorders of the stomach, and the presence of gastric flatus. Pain was a new condition superimposed upon the symptoms of dyspepsia, which had troubled me for years. This conclusion is drawn because the breast pang made itself felt sooner after a full meal than after a spare one, and more frequently after tea in quantity, sweet cakes and jam, or after soup, vegetables, pastry and milk puddings than after a plain dish, such as a grilled chop with no accessories. Moreover, it asserted itself with marked violence when effervescing wines, malted liquors or non-alcoholic sweet beverages had been drunk with the meal. Pain usually abated, or came to an end, when exercise was discontinued, or when flatus was expelled. After several breaks in the journey, and when gastric distension had been relieved by repeated eructations of flatus, a considerable length of road might be traversed without the occurrence of any further manifestation of thoracic discomfort.

The pain induced by walking exercise is precisely of the same character as that experienced in the definite anginal attacks of March, April and May, 1908, except in degree and in the extent of area involved. It commences in the substernal region, and extends to the inner aspect of the arms as far down as the elbows. It seldom reaches backwards to the scapulæ, or affects the jaws or neck. When exercise is persisted in, pain is exaggerated. Upon discontinuance of muscular effort, it is relieved. Abatement follows eructation of flatus, inhalation of nitrite of amyl, or the exhibition of nitroglycerine. On some few occasions when, notwithstanding the urgency of my symptoms, I had persisted in going forward to reach my destination without any further halts, pain in the chest became intolerable, it extended to the jaws and wrists, and began to assume all the characteristics of the anginal seizures already described.

§ 2 Examples of seizures occurring at times of rest.

Blood pressure was frequently estimated in the latter months of 1907. It was generally found in the neighbourhood of 165 mm. Hg.. Sometimes it was noticed to fall as low as 120 mm. and, on a few occasions, it ranged over 200 mm. Both high and low levels were ephemeral, the former corresponding with periods of muscular effort and gastric disturbance.

Through attention to dietetic rules my health has improved. When making a temporary sojourn in the bracing air of the east coast, I have found myself able to walk a distance of 7 or 8 miles without experiencing any pain. Sometimes when walking in London I feel discomfort, not

§ 2 Examples of seizures occurring at times of rest. amounting to pain. Resort to the nitrites is not necessary, for, when perchance a premonitory symptom does make its appearance, a halt of a few minutes' duration determines relief.

The specific gravity of the urine is 1024 with an acid reaction. The presence of phosphates is variable. The colour is dark straw. Deposits of a brick dust character not infrequently stain the utensil. Sugar and albumen are absent.

Constipation is the ordinary habit. Heart sounds are normal. The skin inclines to the sallow type. The whites of the eyes have lost their blue tint, and assume a dirty yellow shade lasting twenty-four hours or more after the ingestion of sweet foods and fermented beverages.

Chronic acid dyspepsia, from which I had suffered for many years, is a form associated with the intake of starch and sugar-bearing foods. It is excited by bread, milk, cakes, pastry, jams, potatoes and fruit. It is encouraged by wines and fermented liquors, and it is accompanied by formation of large volumes of gastric flatus. The effect of the ingestion of any of these articles in quantity is generally noticed one, or one and a half hours, after a meal. The stomach becomes greatly distended and discomfort from distension is aggravated by constrictions of trouser band or waistcoat. Tension is relieved by the expulsion of flatus. Gastric pain is entirely absent.

Always the stomach has been tolerant of meat. Beef, mutton, lamb or pork, fresh or salted, roast or boiled, chicken,

game or fish, crab and lobster. So strong is the stomach in digestion of meat of all sorts that even when swallowed unmasticated lumps it does not provoke discomfort. Indeed, in the absence of starches and sugars digestive organs might properly be described as vigorous."

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times of rest.

In the 20th Century of Medicine, Vol. 4, page 551, Dr. Sansom describes the symptomatology of angina pectoris:—

1. The principal seat of pain is the middle or lower part of the sternum, somewhat to the left; it may extend to the axilla and the back or may radiate up to the neck, the lower jaw or the occiput. In many cases the pain extends down the left arm to the elbow or to the fingers. In these situations it may be accompanied by a sensation of coldness or numbness. It may pass downwards to the lower part of the abdomen or to the testicles. It is not increased by external pressure. Exceptionally it may radiate to the right side, involving the right arm.

2. The pain referred to the sternum is accompanied by a sense of constriction. The suffering is always severe and in some cases an indescribable torture, perhaps the most severe form of pain endured by human nature.

3. The patient, when the attack occurs, becomes motionless in one position. There is no marked dyspnoea but breathing may become shallow or even arrested.

4. The face is usually pale or of leaden hue and bedewed with a cold sweat. The patient waits with intense anxiety, the end of the nerve storm.

5. There is an extreme sense of depression and feeling of impending death; but the attack once over, the patient experiences a sense of free relief and there are not frequent repetitions of pain as in dyspeptic and hysterical cases. In some cases the attack is followed by flatulent eructations or by vomiting.

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occurring at
times of rest.

Sir Douglas Powell has given a description of the clinical features of an ordinary attack of angina pectoris.

“The patient, most commonly a man, and usually between 40 and 65 years of age, is quite suddenly seized whilst under some excitement or engaged in some exertion not unusual or excessive to him, or even whilst in bed after a somewhat fatiguing day, with some pain in the præcardial region. The character of the pain varies. It may be most acute or agonising, of a rending character; or accompanied by a sense of constriction, as though the heart were gripped, or the thorax were severely pressed. Its onset is always sudden, but the pain is sometimes rapidly ingravescent rather than reaching its height at once. Having its principal seat within the præcardial region, usually in the lower mid-sternum, the pain radiates in most cases upwards to the left shoulder and down the arm, to the elbow, or wrist; sometimes similarly to the right shoulder or to the chin and throat, but rarely in a downward direction. This radiation is not essential and varies with the intensity and seat of pain. The countenance becomes pale, and assumes an anxious, panic-stricken expression, sometimes betraying acute suffering, and that apprehension of death which is more or less a feature of the attack. A cold sweat bedews the brow, and the coloration of the lips is livid.

Whatever he may be doing, the subject of true angina, stops short and rests, sitting, stooping, or leaning forward against any support that may be at hand. The breathing at first oppressed, disturbed, and restrained by the pain, then panting or sighing; there is a sense of air hunger, and the patient will motion attendants aside, although himself he dare not stir. The pulse may be little changed, yet it is sometimes tightened. It may be small, hard, thready, and irregular. As a rule it is not markedly quickened, sometimes decidedly infrequent; but in these latter cases, on listening to the heart it will often be found beating twice to each radial pulsation.

During the attack the heart sounds are, as a rule, distant, feeble, and of pure valvular character; the first sound resembling the second. Adventitious sounds, such as murmurs, may or may not be present, but they have no natural relation to the anginal paroxysm. The intensity of the attack may only last a few minutes, and rapidly subside; but it sometimes returns in a series of wave-like recurrences through a period of an hour or more. There is often flatulent distension of the stomach, eructation of flatus giving some relief. It is rare for patients to faint with true angina, except in cases of fatal syncope.”

§ 2 Examples of seizures occurring at times of rest.

Richard Quain describes the general characteristics of the anginous seizure in the following words:—

“An attack of angina pectoris commences suddenly with pain in the region of the heart generally on a level with the lower end of the sternum. The pain is severe and of a grasping, crushing, or stabbing character; it extends sometimes across the chest, but more frequently backwards to the scapula, and upwards to the left shoulder and arm. The pain is accompanied by a distressing sense of sinking, of faintness, and of impending death. The action of the heart is generally irregular. The pulse at the wrist corresponds; but in some well-marked cases it is regular, tense, and resisting. A fear of aggravating the pain prevents the patient from breathing, although the respiratory function may not be really interfered with. The whole surface of the body is pale, cold, and covered with a clammy sweat. Flatulence is often present. Urine is generally passed at short intervals and in abundance.”

In the case of Mrs. K., aged 60 years, anginous seizures occurred in the second week of March, 1920, and were attributed to nervous breakdown resulting from family losses during and after the war. This case is interesting because certain attacks were painful, and certain painless.

§ 2 Examples
of seizures
occurring at
times of rest.

At a meno-pause many years before, attacks had been of frequent occurrence. So severe had they been, that the patient had kept bed for over six months, under constant attendance by day and night nurses. At a later period, attacks attributed to biliary colic occurred, but no gallstone was known to pass.

The first *painful* attack of the March 1920 series, came on suddenly without apparent provocation. Pain was midsternal, radiating to back, neck, left axilla, and arm. Lasting 15 minutes, it ended with explosions of gas from the chest and loud borborygmal sounds. Later attacks followed. At one of the series, I took a graphic record of radial and jugular pulses, which showed nothing abnormal in the curves. A blood pressure reading taken during this attack registered 140 mm. Hg.

The *painless* form of attack begins with a sensation of fulness at the chest, and throbbing of the arteries at the neck. The head feels full, to bursting point, and the face becomes red or purple. As in the painful attack, the dread of instant death prevails. During the seizure, breath hunger is a marked feature. In this matter a wide difference exists between this form of paroxysm and the painful; for, in the latter type, breathlessness is totally absent.

In a painless attack witnessed by me, veins at the root of the neck stood out engorged and throbbing, and arteries in the same region pulsated, and shook the muscular and tendonous structures of the neck. The swelling right ventricle extended widely beyond its normal limitations, and the abdominal aorta pulsating under a raised and rigid lump of rectus abdominus muscle, simulated aneurism in the epigastric region. The pulse at the wrist was large, full, and bounding. Veins of the face, brow and temples were congested. Lips were purple and swollen. Pulsations at the wrist numbered 110 beats a minute, and rhythm was broken by numerous

extra-systoles. After the attack, which lasted 25 minutes, was over, extra-systoles became less frequent, pulse registered 80 beats a minute, and right ventricle returned to normal proportions.

Arterio-sclerosis is present. At intervals between attacks artereal pressure stands at 200 mm. Hg. At the end of both painful and painless seizures, abundance of pale urine is passed.

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Section 3. *Anginous Attacks associated with Defecation, with Food Taking and with Mental Excitement.*

IN the case of Dr. X. after the anginous habit had been in existence for ten years or thereabouts, a symptom, previously unrecognised, appeared, and became a recurring content of the syndrome. Thoracic pain associated itself with discharge of the contents of the colon. Dr. X. noticed discomfortable pressure sensations in the region of the synchondrosis, heralding the approach of a call to stool; a sensation which attended the action itself, and which remained in evidence 20 to 30 minutes afterwards. Sensation of pressure often merged into pain, which was relieved, or vanished wholly, when flatus was expelled from the chest. It mattered little whether the action was free, or whether it was accompanied by effort or straining. Indeed, strange to say, straining rather relieved this form of discomfort than

§3. Anginous attacks associated with defecation

§3. Anginous
attacks
associated
with Food
taking.

aggravated it. But discomfort was notably increased during cold weather, and particularly when a considerable area of skin was allowed to remain uncovered during intestinal action or immediately after it; and it was increased and assumed a more painful character, after Dr. X. had walked along the short passage which led from the lavatory to his study. The period of duration of colonic disturbance, that is to say, during twenty minutes before stool, and half-an-hour afterwards, was a period of the day particularly favourable for the excitation of anginous seizures.

About this time another symptom worthy of remark forced itself upon the attention of the patient. Thoracic discomfort, relieved by the expulsion of flatus, appeared after the first few mouthfuls of food had been taken at meals; when gas was not expelled pain became intolerable, and continuity of the meal was interrupted. At length Dr. X. dreaded the sight of food, and sensations of thoracic pressure and even pain, came on when food appeared on the table, and before he had begun to eat. Sensations such as these, closely related with food taking, lasted five or six weeks, and then went and did not return.

In the case of Dr. X., attacks are common enough during states of mental excitement, or when the mind is suddenly depressed through ill news, or other disturbing influences. Attacks from these causes are excited more readily during or after food taking than when the stomach is empty. When the colon is empty, they do not come on as readily as when it is full. Regions affected, and character-

istics of discomfort and pain, are the same in attacks from these causes as in attacks excited by walking. Relief comes when exhaustive volumes of gas have been expelled from the chest.

§3. Anginous attacks associated with Mental excitement.

A strong wind blowing in the face of the anginous subject when he is walking is an efficient excitant of seizures. That the wind be cold is not an essential condition. I have known on occasion severe attacks follow from exposure to strong warm winds. Yet cold winds are more fruitful of attacks than warm. Certain Anginous subjects take cold baths in warm weather without experiencing any bad effect.

Anginous subjects may drive many miles in the teeth of a gale without being affected by it, yet, were they to get out and walk one hundred yards facing it, several halts might be necessary before the goal was reached. Certain persons under observation have found themselves able to walk considerable distances without pain after taking a short drive; yet, before they had set out, their inability to walk more than a few paces was fully recognised by them.

Seizures excited by walking, by defecation, by eating, by excitement, or such as come on when functions are quiescent, and when the body is not exposed to any external unsuitable influence, are similar in this respect; they are attended by gastric symptoms.

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Section 4. *Heberden's Classic Description of Anginous Symptoms.*

§4. Heberden's classic description of anginous symptoms.

HEBERDEN'S Commentaries published in 1801, and his contributions to the transactions of the Royal College of Physicians, 1772 and 1795, still remain the chief classics of the angina pectoris.

"Angina," a term in common use by Latin writers, was universally applied in Heberden's day to define diseases of the supra-diaphragmatic portions of the alimentary canal. Angina of the moribund was dysphagia or difficult deglutition preceding death. This mode of employment of the term then in vogue indicates Heberden's conception of the nature of the complaint. Nowhere in his writings as far as I am aware does he refer to the heart as the seat of it. He writes:—

"There is a disorder of the breast marked with strong and peculiar symptoms, considerable for the kind of danger belonging to it, and not extremely rare. The seat of it, and the sense of strangling and anxiety with which it is attended, may make it not improperly be called the angina pectoris. Those who are affected with it are seized while they are walking, more particularly if it be uphill, and soon after eating, with a painful and most disagreeable sensation in the breast, which seems as if it would take life away, if it were to continue or to increase, but the moment they stand still, all this uneasiness vanishes."

"In other respects the patients are at the beginning of

this disorder perfectly well; and, in particular, have no shortness of breath, from which it is totally different. The pain is sometimes situated in the upper part, sometimes at the middle, sometimes at the bottom of the os sterni, and often more inclined to the left than the right side. It likewise extends from the breast to the middle of the left arm. The pulse is at least sometimes not disturbed by this pain, as I have had opportunities of observing by feeling the pulse during the paroxysm.”

§4. Heberden's classic description of anginous symptoms.

“After it has continued a year or more, it will not cease so instantaneously upon standing still, and it will come on, not only when the persons are walking, but when they are lying down, especially if they lie on the left side, and oblige them to rise up out of their beds. In some inveterate cases, it has been brought on by the motion of a horse or carriage, or even by swallowing, or coughing, or going to stool, or speaking, or disturbance of mind.”

“Such is the most usual appearance of this disease, but some varieties may be met with. Some have been seized while they were standing still or sitting, also upon first waking out of sleep, and the pain sometimes reaches to the right arm as well as to the left, and even down to the hands; but this is uncommon. In a very few instances the arm has, at the same time, been numbed and swelled. In one or two the pain has lasted some hours or even days. But this has happened when the complaint has been of long standing. Persons who have persevered in walking till the pain has returned four or five times have then sometimes vomited. The angina pectoris, as far as I have been able to investigate, belong to the class of spasmodic, not of inflammatory complaints.”

In another place Heberden says:—

“The os sternum is usually pointed to, as the seat of the malady, but it seems sometimes as if it were under the lower

§4. Heberden's
classic
description
of anginous
symptoms.

part of it, and at others about the middle or upper part; but always inclining more to the left side, and sometimes there is joined with it a pain about the middle of the left arm. But, though it is most probable that a strong spasm is the true cause of this disorder, yet there is some reason for thinking that it is sometimes accompanied with an ulcer, and may partly proceed from it, for I have seen two or three patients who often used to spit up blood and purulent matter, one of whom constantly asserted that he felt it come from the seat of the disorder. Another had a painful sensation when swallowing."

"A man in the 60th year of his life began to feel, while he was walking, an uneasy sensation in his left arm. He never perceived it when he was travelling in a carriage. After he had perceived it for years, it would come upon him while he was in bed, and then he was obliged to sit up for an hour or two before it would abate sufficiently to suffer him to lie down. In all other respects he was healthy, and had always been a remarkably strong man. The heart was never affected. This disorder, the seat excepted, perfectly resembled the angina pectoris; gradually increasing in the same manner, and being excited and relieved by all the same causes. He died suddenly without a groan at the age of 75."

Section 5. *Description of Symptoms of the "Unknown,"*
written in his own Words.

ON this case Heberden makes the following comments—
 "The sensation described in the letter of an apparent suspension of life for a few seconds is what I do not remember to have ever heard mentioned by any patient besides this; and, though I say in the former paper on this disorder that I have seen it in 20 persons, I may truly say that I have seen it in 50. In this particular case, that inward pause of the vital actions is said to have been felt when the patient was sitting, standing, and at times in his bed. Now, as he was seized while he was walking with those symptoms which ended in his death, which I remember to have happened to other of his fellow sufferers, it may seem more probable that he lost his life by an extraordinary aggravation of his angina pectoris, than of this particular sensation; but this must be decided by future experience."

§5. Description
 of symptoms
 of the
 "Unknown."

Extract from the letter signed "Unknown," April 16th, 1772:—

"I am now in the 52nd year of my age, of a middling size, a strong constitution, a short neck, and rather inclining to be fat. My pulsations at a medium are about 80 in a minute. The extremes, when in a perfect state of health, beyond which I scarcely ever knew them, 72 and 90. I have enjoyed from my childhood so happy a state of health as

§5. Description
of symptoms
of the
"Unknown."

never to have wanted, nor taken, a dose of physic of any kind, for more than twenty years. As well as I can recollect, it is about five or six years since, that I first felt the disorder which you treat of. It always attacked me when walking, and always after dinner, or in the evening. I never once felt it in a morning, nor when sitting, nor in bed. I never ride, and seldom use a coach, but it never affected me in one."

"The first symptom is a pretty full pain in my left arm, a little above the elbow, and in perhaps half a minute, it spreads across the left side of my breast, and produces either a little faintness or a thickness in my breathing, at least I imagined so, but the pain generally obliges me to stop. At first, as you observe, it went off instantaneously; but of late by degrees. If, through impatience to wait its leaving me entirely, I resumed my walk, the pain returned. I have frequently, when in company, borne the pain, and continued my pace without indulging it, at which time it has lasted five to perhaps ten minutes, and then gone off, as well as I can recollect, rather suddenly as it came on, than lessening gradually. Sometimes I have felt it once a week; other times a fortnight, a month or a longer time, may elapse without it once attacking me. But I think I am more subject to it in the winter months than in the summer months. As when the pain left me I had no traces of the least disorder within me of any kind, I never troubled myself much about the cause of it, but attributed it to an obstruction of the circulation, or to a species of rheumatism."

"I shall now proceed to acquaint you with those sensations, which to me seem to indicate a sudden death, but which, not being concomitant with the above-mentioned disorder, I am ignorant whether they are to be attributed to it or not. I have often felt when sitting, standing, or at times in my bed, what I can but express by calling it a universal pause within me of the operations of nature, for perhaps three or four

seconds. When she has resumed her functions, I have felt a shock at the heart like that which one would feel from a small weight being fastened by a string to some part of the body, and falling from the table to a few inches from the floor. At times it will return twice or thrice in half-an-hour, at other times about once a week, and sometimes I do not feel it for a long time. I think I have been less subject to it for a year past than for several former ones."

§5. Description
of symptom
of the
"Unknown."

Of the autopsy on the famous case of the "unknown" performed by John Hunter, Heberden says—"The contents of the thorax were examined with peculiar attention, particularly the heart, with its vessels and valves, and were all found to be in a natural condition, except for some few specks of a beginning ossification upon the aorta, and some adhesion of the lungs to the pleura on the left side. The left ventricle of the heart was strong and thick, and as perfectly emptied of blood as if it had been washed."

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Chapter II.

Description of Anginous Symptoms ; Pain.

- Section 1. The Source of Anginous Pain.
- Section 2. Types of Pain.
- Section 3. Direct Visceral Sensations.
- Section 4. Diffused Visceral Sensations.
- Section 5. Deflected Visceral Sensations.
- Section 6. Starting Points of Pain.

Section 1. *The Source of Anginous Pain.*

§1. The source of anginous pain.

THE hypothesis advanced in this work, which allocates the source of anginous pain to muscular tunics of the gastro-œsophageal portion of the alimentary canal, commends itself to our consideration upon the following grounds, namely: (1) Involuntary muscle is the sole visceral organ of special sensory impressions merging into pain. (2) Special sensory impressions such as are generated by no other organ of sense, except the musculature of the gastro-œsophageal track, namely sensations of fulness and oppression at the chest, nausea, desires to retch, to eructate gas, and to

vomit, and globus are very commonly felt at the beginning of anginous seizures; these sensations merge through gradations of intensity and without break, into discomfort and anginous pain. (3) Anginous pain is felt in segmentary zones at or behind the upper part of the sternum, at mid-sternum, and at the lower end of the bone, sometimes in one of these regions, sometimes in another; that is to say in segmentary zones traversed by the œsophagus, spinal centres of which are in receipt of afferent impressions from the muscular tunic of this organ. (4) Dr. Hertz in his Goulstonian Lectures on the sensibility of the alimentary canal has demonstrated that uncomfortable sensations precisely similar in all essential particulars to those described above as anginous, can be experimentally produced by causing hypertonus of the gastro-œsophageal muscular tunic, through introduction and inflation of a balloon in the track. In these experiments retro-sternal discomfort is felt at zones where hypertonus is occurring. The different retro-sternal planes at which anginous pain is felt, and the nature of special sensations experienced in anginous seizures, are thus rationally accounted for by the hypothesis advanced in these sections. (5) Gas imprisoned in the stomach provokes and sustains attacks and its liberation ends them.* See Chapter 4.

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* It is asserted by exponents of the hypothesis of the cardiac reflex, that these sensations described by me as gastro-œsophageal, are in reality generated in the myocardium or else are determined through myocardial influence on the stomach. This influence is not in accord with clinical experience. Before me I have notes of seven cases in which systemic blood pressure ranges between 220 and 280 mm. Hg. One of these persons, under observation for eight years, has during this period

Section 2. *Types of Pain.*

§2. Types of pain.

ALL sensations are referred. Felt in the sensorium, they are referred to the part whence their stimuli spring, or to other parts. During anginous seizures, stimuli, which excite them, are generated at terminals of sympathetic nerves in the muscular tunic of stomach and œsophagus. From sympathetic system impressions from these stimuli are transferred to spinal. They are conveyed through splanchnic nerves to sympathetic chains, and thence through posterior roots to segmentary centres of the thoracic and cervical cord. They are generated by hypertonus and belong to three types, namely: (1) Sensations recognised by their special character and referred back to their original source; (2) Sensations referred diffusively to subserous tissues of pleural, pericardial and peritoneal sacs and (3) Sensations referred to inter-costal, to brachial, and to cranial nerves. To these several types of referred sensations the following

registered a pressure never less than 200 mm. Hg. Yet none of them has ever within my knowledge complained of gastric, nor thoracic distress. Compare these figures which are applicable to intraventricular pressure, with those of Dr. Hertz's experiments relating to the effects of intragastric and intracœsophageal pressure, in the production of symptoms. In the latter instance discomfortable sensations were produced at respective pressure of 14 and 38 mm. Hg. In the former instances intraventricular pressure attaining 280 mm. produce no sensations whatsoever. It is inferred that the myocardium does not lie on the pain tracks. This conclusion is confirmed by physiological research: afferent nerves of heart muscle are not in touch with the sensorium.

brief designations are applicable: (1) Direct visceral sensations; (2) Diffused visceral sensations and (3) deflected visceral sensations.

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Section 3. *Direct Visceral Sensations.*

THE muscular tunic of the gastro-oesophageal track is §3. Direct visceral sensations. the organ of special sense for this portion of the alimentary canal. When tonus against resistance is raised, sensory impressions are generated. As in the case of an obstructed rectum, bladder, or gravid uterus, after contents of the cavity have been expelled, resistance against contractile impulses ends, tonus subsides, and uncomfortable sensations are no longer felt.

A paralled is found in voluntary muscle. Through contractile action against resistance, muscles of palpation gauge the compressibility of objective bodies. Degrees of output of tonic energy, measured at central stations, are recorded by the sensorium. When a stone is handled, although its hardness is apparent, the source of generation of the subjective impression is unknown by the untutored mind. Consciousness is informed by tactile impressions that a subjective body is handled. But tactile sense takes no count

§3. Direct
visceral
sensations.

of the compressibility of bodies. This question is left over for muscle sense to decide. Nevertheless the source of muscle sense impressions is not known to consciousness. It is inferred by consciousness that the sensation of incompressibility comes from the object which excites tactile impressions. Hence hardness is referred to the stone, and not to the sensory organ, which actually produces the sensation through which it is recognised.

Neither œsophagus nor stomach is furnished with tactile nerves. Their muscular tunic is the sole organ of sensory impressions. Sensations generated by visceral muscle, inform us upon the nature of special functions engaged in, by the organ to which they appertain. They do not fix the precise locality of the viscus. But the viscus whence they spring is recognised through the character of its sensations.

When pain is felt these finer sensations are merged in it, but they lose much of their special character. For instance, when fingers engaged in palpation, are cut by a sharp spicula or edge, and pain from the wound is felt, tactile sense and the faculty employed in estimating degrees of compressibility, cease to offer information.

So in the angina pectoris, qualminess, nausea, a desire to eructate gas, and globus, are initiatory symptoms of rising tonus in gastro-œsophageal muscle. But when tonus has reached a high degree of intensity, these symptoms merge into pain, and then those signs which denote the finer special functions of the muscular tunic of the gastro-œsophageal track, are banished from consciousness, and cease to be

recognised as partakers in the syndrome. After disappearance of differential signs, the viscus at fault remains masked. §3. Direct visceral sensations.

In another place I have described segmentary neurosis as the predisposing cause of seizures. The effect of this condition on the musculature of organs compels us to look beyond physiology for the explanation of symptoms. A high state of tonus in gastro-oesophageal muscle during healthy conditions of segmentary centres is painful; but, when centres are hyper-irritable, it is agonising. Moreover, during states of neurosis, tonus of the gastro-oesophageal track may remain highly elevated even in the absence of resistance. Since anginous pain is generated by gastro-oesophageal muscle while in a state of high tonus, so it may be sustained by the continuance of hyper-tonus, even after gas and food have been expelled from the gastric cavity. Hence, in old standing cases of angina pectoris, pain is occasionally found remaining in evidence, even in the absence of high intragastric pressure, and when the contents of the stomach have been expelled by vomiting.

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Section 4. *Diffused Visceral Sensations.*

§4. Diffused
visceral
sensations.

THE field of reference of diffused sympathetic sensations is subserosal. Subserosæ sublying pericardial, pleuritic, and peritoneal sacs are traversed by a dense network of sympathetic fibrillæ. They also contain those great plexuses which extend in continuous series from skull to pelvic regions, including in their number cardiac, pulmonary, œsophageal, gastric, and other splanchnic groups. From these plexuses, ramify reticular formations, which conduct sensible impressions, to and fro, between viscera and centres of the sensorium.

In this gossamer of sympathetic fibrillæ are pain tracks. Threading a way, through the tangle of this neuronie field, are vaso motor nerves. In the length and breadth of this field, diffused sympathetic sensations disport themselves, regardless of gross anatomical boundaries, and defying efforts of localisation. These phenomena are distinguishing features of diffused sympathetic sensations. Of this order are those waves of hot and cold sensations which fathom the depths of thoracic abdominal and pelvis cavities, and are described by some as hot or cold water pouring down the spine, and of this order are those sickening indescribable waves of pain which arise and swell when testicle or abdominal organs suffer from a crushing blow.

During continuance of these diffused sensations the anginous subject is conscious of the bursting and crushing pain in the thorax, to which reference is frequently made by writers, and during this phase, he retches, expels gas, vomits sheds tears, trickles at the mouth, suffers relaxation of the sphincter of the bladder, and sweats. At this season also integumental coldness and pallor are marked features.

Diffused sympathetic pain is not felt in integuments, nor in tissues of the thoracic walls. It is beneath the parietal wall—it is retro-sternal and retro-costal.

Results of an operation performed by Mr. Morison and described in *The Lancet* of January, 1910, are suggestive of marks of distinction, between pain referred to terminals of intercostal nerves and retro-sternal and retro-costal diffused sensations and pain. Dr. Morison had removed intercostal muscles, and had divided the 5th and 6th intercostal nerves in a person subjected to anginous seizures. Yet, notwithstanding removal of muscle and division of nerve, anginous seizures were characterised as hitherto with retro-costal pain, which before the operation, had been attributed in error to intercostal sources.

Writers of early and late times have laid stress upon the retro-sternal and retro-costal situation of pain felt in the angina pectoris.

Heberden speaks of the substernal seat of pain. Sir Clifford Allbutt draws particular attention to this feature, and mentions many references to the subject by writers of authority. Certain of these references are given below.

Whichmann speaks of "a bar across the upper part of the chest, the pain being, as it were, within the chest." Trousseau describes it as "behind the sternum." Broadbent wrote, "the pain is chiefly behind the sternum—it is vice-like, a tearing or a burning." Sir William Osler describes it as "agonising substernal pain." In another passage he says

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visceral
sensations.

"the maximal intensity of the pain is substernal," but in some "at the ziphoid." Barrie insisted again and again on the retro-sternal seat of the pain. Mitchell Bruce describes the sense of oppression as "behind the sternum."

Upon subparietal sensations induced by walking, Dr. X. made observations on a large number of attacks occurring in his own person.

On walking they were felt in retro-costal regions, just below the horizontal plane of the synchondrosis, and on either side of the sternum, at about half-an-inch from sternal borders. If walking were continued, radiation took place, towards the left axilla, towards the right, or in both directions. Afterwards the whole thoracic contents seemed to participate in the discomfortable sensation. Parietal and brachial pain started later, and were differentiated without difficulty, from retro-costal pain.

Dr. X. describes another mode of initiation of seizures. The first threat of attack comes as a dull aching in deep epigastric or retro-ziphoidal regions, which, extending upwards to substernal regions, reaches the synchondrosis, and then spreads fan-like to deep regions behind anterior axillary folds

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Section 5. *Deflected Visceral Sensations.*

§5. Deflected
visceral
sensations.

IN this type, sensations are deflected from their visceral source, and referred to terminals of segmentary spinal nerves, chiefly intercostal and brachial. Intercostal and brachial sensations usually appear in consort with visceral diffused and visceral direct sensations; but occasionally they are manifested alone, unattended by other types; such, for instance, is the case when anginous sensations are represented solely by brachial pain.

To contemporaneous manifestations of deflected and §5. Deflected visceral sensations. diffused visceral sensations is owed the conflict of opinion between careful observers as to the chief seat of pain in the angina pectoris; a number of writers asserting that pain is intercostal and sternal, whereas an equal number are confident that it is retro-costal and retro-sternal. Since sensations of the diffusive type are less tolerable than those of other types, they outclass and overshadow them. During their prevalence, mind is concentrated upon them, and types of lesser significance sink below the plane of consciousness. No wonder that Sir William Osler speaks of agonising substernal pain, and asserts that "the maximal intensity of the pain is retro-sternal." Sir William Broadbent, recognising the presence of sternal pain, writes:—"The pain is chiefly behind the sternum; it is vice-like, a tearing or a burning."

When patients complain of shooting or stabbing pain, whether it come alone, or in conjunction with other types, we recognise in it an example of deflected visceral sensations, for pain of other types is usually neither shooting nor stabbing.

From Miss A.'s description of pain occurring during seizures, not witnessed by me, I drew the conclusion that it belonged to the diffused type; she could not exactly define its situation. A few days afterwards she drew my attention to a blue pencilled mark on the skin, which she informed me was made in the early morning during a seizure. This line lay athwart the course of 3rd, 4th, 5th and 6th left intercostal nerves, crossing over them at points of out-crop of their cutaneous branches, at costo-chondral articulations. She stated that during dull aching pain, which was spreading in waves within the chest, sharp cutting pain was shooting just beneath the skin at this line. This is an apt example of visceral deflected pain.

Visceral deflected pain frequently takes the course of the line drawn by Miss A., and it is usual, when it occupies this situation, for patients to call it a heart pain. Pain of the

§5. Deflected
visceral
sensations.

same character not infrequently selects a corresponding site on the right thoracic wall. But, in whatsoever situation it manifests itself, it preserves the same lancinating character. It skips from terminal to terminal of intercostal nerves, that is to say, it runs across the course of these nerves, not with them. One or more of the series from 2nd to 9th, are subject to visitation. Sensations in jaws and arms partake, somewhat, of the diffusive character: but in these situations pain can be lancinating also. Although deflected visceral pain may, occasionally, be of a dull aching type, it is commonly acute and shooting. In contra-distinction from the diffusive type, it is excursive rather than diffusive.

Fothergill describes it as a constrictive pain seated in the sternum, usually in the upper part, and passing across the left breast into the arm.

Parry describes the pain as mid-sternal crossing to the left side; and Jurine, as a sternal pain crossing the chest; Wall, as a pain in the upper sternum crossing over both pectoral muscles. Sir Lander Brunton writes, the site of the pain is usually over the sternum, sometimes at its lower, sometimes at its upper part; sometimes it is more to the left, or may wander to the right of the sternum. Laenec speaks of the pain as sometimes seated about the left pectoralis major. In commenting on the findings of these writers, Sir Clifford Allbutt says, "In some cases in my notes, and in some others which I remember, the chief seat of the pain was not exactly sternal, but a little to the left of the upper part of the bone, about the second or third interspace."*

With this observation of Sir Clifford Allbutt I agree. Indeed, in my experience, although pain is frequently retro-

* Diseases of the Arteries. Volume 2, page 284.

sternal, it seldom occupies a place over the bone. As far as I have been able to ascertain, pain is never in the first intercostal zone, nor in the pre-manubrial region.

In a number of cases, pain brought on by walking, is primarily felt in inter-scapular regions, either central or adjacent to the lower two-thirds of the posterior border of the scapula, and generally at the left side; but it may be felt at the right side of the spine, and in certain instances on both sides. Sometimes the seat of chief intensity is shifted from this region to the line of anterior axillary folds, outside nipple lines and curving forward beneath the cushion of the breast. In the case of Dr. X., day after day for several weeks, these situations were chosen whensoever he walked. During this time, pain bordering on the sternum was absent, but after this period of exceptional incidence, was over, it resumed its former site.

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Section 6. *Starting Points of Pain.*

IN the case of Miss E., during an illness lasting over five years, more than four hundred observations were made with a view of ascertaining the starting points of intercostal pain during seizures, which were occurring with great frequency. They came on whensoever she walked a few paces, when she became excited, and when indigestible food-stuff had been taken. An intelligent nurse was instructed, as

§6. *Starting points of pain.*

§6. Starting points of pain.

to how, in my stead, she might best keep records of modes of initiation of these attacks. The plan adopted was that of marking the seat of initiation of pain on a diagram, which pictured boldly the skeletal frame. At visits paid in the ordinary course of my round, I obtained evidence and particulars of attacks recorded during my absence, and thereby tested their accuracy.

In one hundred and ten instances, pain began at sections of 2nd and 3rd intercostal spaces, near left and right sternal borders. In twelve instances at corresponding points at the left side alone. In six instances it was first felt at parts of 3rd and 4th intercostal spaces, near left sternal border. In twenty-two in 3rd and 4th interspaces at vertical lines, corresponding with anterior axillary folds. In fifteen instances in retro-zipoid area; in thirty-two the seat of its initiation was inter-scapula; in forty in right shoulder; in fifteen in right arm; in twelve in left arm at mid third; in twenty-three instances pain started at left hypo-chondrium, and darted upwards to the left of the sternum at points of out-crop of intercostal nerves, near costo-chondroid articulations; in twenty-nine its initial seat was indeterminate.

Certain seizures herein noted were severe, but far the greater number scarcely merited the name "paroxysm." They were attacks of thoracic discomfort, or pain, brought on by muscular effort, such as that of walking upstairs, rising from the table, walking from room to room soon after meals, from excitement, or from emotion.

Conversely, pain is referable from cerebro spinal system to sympathetic system, and experimentally can be induced by exercising pressure over the right rectus abdominis muscle, and also by the adjustment and inflation of the arm piece of the hæmomanometer. From both these situations, through the application of pressure, a shaft of pain was made to penetrate to retro-costal regions.

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Chapter III.

Description of Anginous Symptoms : Tender spots.

- Section 1. Hyper-æsthesia at Peripheral Terminals of Nerves is a Mark of Hyper-irritability at Segmentary Centres.
 Section 2. Persistency of Hyper-æsthesia through Inter-paroxysmal periods means Chronicity of Segmentary Neurosis.
 Section 3. Anæsthesia.

Section 1. *Hyper-æsthesia at Peripheral Terminals of Nerves is a Mark of Hyper-irritability at Segmentary Centres.*

TO reduce the subject to simple terms, Hyper-æsthesia §1. Signifi-
 of dendrites of neurons is proof that these processes ^{cance of} tender spots.
 are hyper-irritable, and since a neuron, hyper-irritable in one part is also hyper-irritable in all, so the presence of hyper-æsthesia at peripheral nerve endings is proof of the existence of hyper-irritability of the centre.

When cell bodies lodged in segmentary centres are hyper-irritable, their disaffection spreads in neighbouring neurons in the same and in adjoining centres, and it may reach

§1. Signifi-
cance of
tender spots.

even distant centres. If the neuron affected be sensory, hyper-æsthesia is manifested by its dendritic processes; if its function be motor, spasm and rigidity occur in muscular fasciculi innervated through its axonic process. Hyper-æsthesia, agonizing pain and rigidity of muscle manifested in the same segmentary zone, are sure signs of hyper-irritability at the zonal centre.

Neurosis in zonal sections of the cord is made evident by the manner of incidence of hyper-æsthetic symptoms. In thoracic distributing zones, hyper-æsthesia is displayed with much clearness. Here trunks of intercostal nerves underlie muscle and aponeurosis, and are not open to the test of palpation. But, at certain parts of the course of the trunk, superficial branches are given off, which, after piercing superstructures, deploy in sub-integumental space. Discrete spots of tenderness are wont to appear in isolated zones, and clusters of spots, may dog the ramifications of a single spinal nerve. It is common for tender spots to affect, one, two, or three distributory zones, either neighbouring, or distant.

Sometimes tender spots occupy corresponding situations in opposite lateral zones. They come in clusters, rise into evidence, remain fixed for several hours, disappear and reappear. Charts marking these sites are kaleidoscopic, and never two days alike. A few hours after tender spots have been located, they are searched for in vain, while ground previously innocent of tenderness is found producing prolific crops. Where strands are most numerous, that is to say, at points of outcrop, tenderness is felt more keenly than

elsewhere. In each lateral segmentary zone, there are five such points, and each point is a potential seat of maximal tenderness. All intercostal nerves, except the first of the series and the abdominal group, present the same anatomical features.

§1. Significance of tender spots.

In rare cases of the angina pectoris all points of potential maximal tenderness are affected in their turn. In one such case, to illustrate this complete phase of symptomatic expression, a diagram, representing anterior and posterior aspects of thoracic walls, was framed, and upon it the situation of tender spots was marked. Between them, lines were drawn connecting together members of each vertical series.

When completed, the diagram presented five perpendicular columns at either side of the chest, each depicting a series of spots, extending from second to sixth intercostal space, Enumerated from before backwards, these several linear series were located in the following anatomical situations:—(1) at border of sternum, (2) at costo-chondroid articulations, (3) in the line of the anterior axillary fold, (4) at posterior border of scapula, and (5) at spinous processes of vertebræ. Tenderness at these points is best elicited by deep pressure over them. Skin in their vicinity raised up from the general surface between finger and thumb and gently pinched often manifests tenderness.

Besides tender spots in thoracic walls, are others connected with the abdominal group of intercostal nerves. They are located at either side of the median line in the

§1. Significance of tender spots.

epigastric region, and are found also at heads of attachment of recti abdominis in right and left hypochondriac regions. Pressure over tender spots in the epigastrium excites anginous pain, which on occasion strikes into the depths of the thoracic cavity. The same phenomenon occurs when the cuff of the manometer is inflated. Yet, strange to say, no similar result follows pressure over tender places in thoracic walls. In most instances, when pressure is relaxed, anginous pain instantly subsides, but not so always, for I have known prolonged seizures follow in the train of this procedure.

Strands of brachial plexuses in posterior triangles of the neck, and branches of these plexuses in the arms, are subjects of neurosis, and are found tender on pressure. Tenderness is felt when the posterior border of trapezias is pinched between finger and thumb; it is also felt in sterno-mastoids, and at spines of lower cervical vertebræ.

Certain patients sleep on their backs, because continued pressure over deltoid muscles at points of insertion into the humerus excites pain. Sometimes, when one deltoid is overlaid, pain is felt in the other. In many cases continued pressure over humeral, ulnar, radial, carpal, metacarpal, or phalangeal regions, elicits pain. In all regions alike hyper-æsthesia is ephemeral. It forsakes one zone to appear in a neighbouring, or in a distant zone.

Only a fractional number of potential seats of tenderness in the case just described were occupied at one and the same time. The summation as pictured on the diagram referred to was the aggregated result from numbers of daily observa-

tions, extending over months, during which time, favoured
zones such as the 3rd, 4th, and 5th left intercostal, were
occupied again and again. The feature of ephemeral incidence
was envisaged as strongly in this case as in others. This
case is introduced with the purpose of emphasising the great
extent of range of the segmentary neurosis, and the value of
this symptom in differentiating affected segments.

§1. Signifi-
cance of
tender spots.

Symptomatic expression of segmentary neurosis through
hyper-æsthesia is not a property belonging exclusively to the
angina pectoris. It is found in all forms of spasmodic
disorder affecting the musculature of the alimentary canal,
and viscera associated with it, in developmental history, and,
indeed, in all instances where dendritic processes of spinal
or sympathetic neurons are exposed to continued irritation.
Nevertheless, its recognition is of signal value in the inter-
pretation of symptoms, and it gives an indication of the
zone or zones from which irritative impressions start.

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Section 2. *Persistency of Hyper-æsthesia through Inter-paroxysmal Periods means Chronicity of Segmentary Neurosis.*

§2. Chronicity
of segmentary
neurosis.

DURING an illness lasting more than five years, occurring in the case of Miss E., seasons of frequency and intensivity of anginous seizures, and seasons of quiescence, were noticed. But whether seizures were frequent, or in abeyance, the hyper-æsthetic symptom was constant. Examination of thoracic wall was made at least as often as once a month; at certain seasons, weekly, or even daily; yet on none of these examinations were tender spots searched for in vain. In certain instances when I had failed to detect tender spots on the anterior wall, I discovered them on the dorsal, and then not infrequently at spinous processes. On certain other occasions when wholly absent from chest walls, they were found in hypo-chondriac or epigastric regions, and, sometimes, over strands of brachial plexuses.

At seasons of frequency and severity of attacks, hyper-æsthesia was strongly marked. During a period of ten days' duration, when life was constantly under threat from vagal inhibition, and when pain was agonising, tender spots were found in intercostal zones, at almost every potential point of maximal expression. Every movement of the trunk was attended by pain. Moreover, rigidity of intercostal, recti abdominis, and diaphragmatic muscle, rendered respiratory action difficult, reduced potential energy of intra-thoracic minus pressure, and lowered proportionately expansile action in the auricles, allowing blood to accumulate in venous channels; a condition made apparent through livid tinctures of ears, lips, and integuments of face, neck and arms. The thoracic wall, frame and texture of which, stretched taut through muscular rigidity, shook in response to every beat of the heart, and propagated its pulsations and sounds to distant parts.

In these features of a severe phase of anginous expression, hyper-æsthesia played a prominent part.

Contrast the features of this case with those of others, when hyper-æsthesia must be searched for through testing points of potential maximal tenderness in turn.

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Section 3. *Anæsthesia.*

WHEN dining at Middle Temple Hall the other night, a man seated at the same mess handed me a soup plate without wincing, yet when I took it from him it burnt my fingers; later I learned that this man suffered occasionally from anginous seizures. §3. *Anæsthesia*

Dr. X. can handle plates which other persons would shrink from touching, yet his skin is tender as compared with that of the man at the Temple dinner. Besides impaired sensibility to impressions of heat, sensibility to tactile impressions is partially lost. Size and thickness of coins while in the pocket are not readily recognised, and differential gradations of pulse pressures cannot be distinguished. In the case of Mr. J., anæsthesia in the matter of heat and tactile sensations is recognised, yet deep sensibility in the palms of the hands, and at the soles of the feet, is exaggerated. He cannot stand long without inducing sensations of tenderness, nor yet can he sustain his grasp on the handle of a hammer

§3. *Anæsthesia* or chisel for many minutes together without provoking painful impressions. Patches of skin on thighs, buttocks, and abdominal walls feel cold to the touch, and tingle. A patch on the outer aspect of the lower third of the right thigh, becomes quite uncomfortable from a sensation of pins and needles when he has walked a few hundred yards. When he awakens in the morning, scrotum and penis are cold to the touch.

An anæsthetic state of the soles of the feet was noticed by Dr. X. in the morning on setting out to walk. The lack of sensation suggests that he is walking upon a cushioned surface, and that his feet have no grip upon solid ground. After walking for ten minutes or so, this impression wears off.

Certain anginous subjects, when scratching a smooth surface of skin—and more so when the skin is rough—believe that scales of skin are being dislodged, and gather beneath their nails. The sensation so produced induces them to continue scratching, and the habit grows until skin previously smooth becomes the seat of roughness and induration. The habit is difficult to cure.

Owing to anæsthesia at the tips of the fingers, inability to do fine needlework is frequently experienced; when the eyes are off the work, the needle slips from the grasp.

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Chapter IV.

Description of Anginous Symptoms : Gastric Disorder.

- Section 1. Gaseous Eructations a Symptom of the Anginous Syndrome.
 Section 2. Gas, as a Medium of Initiation, Sustenance, and Ending of Seizures.
 Section 3. Bubbling Slime.

Section 1. *Gaseous Eructations; a Symptom of the Anginous Syndrome.*

SUFFICIENT evidence is drawn from the works of §1. Gas a prominent symptom of the syndrome writers on the subject to show that eructation of gas is a prominent symptom in the angina pectoris; that imprisonment of gas in the stomach provokes and sustains seizures and, that its liberation ends them.

In his work on diseases of the heart, Sir James Mackenzie writes :—" Another symptom is extremely common in these cases of anginous seizures, namely the belching of air." The chief feature is the noisy expulsion of air from the stomach, and again, " The case may end by expulsion of air

§1. Gas a prominent symptom of the syndrome

from the chest." In Allbutt's System of Medicine, Sir Douglas Powell remarks, "Eructation gives relief." "The patient vomits and becomes easier." "Flatulent distension of the stomach is frequently an exciting cause." "Flatulent distension is a frequent concomittant of anginous paroxysms." Buck, in the handbook of medicine, observes, "It passes off with the escape of flatulent air from the stomach." The same author in another place remarks, "Stomach often affected, gives rise to eructation and vomiting." In "Medical Diagnoses" Stevens writes:—"Exciting cause, over-loading the stomach." . . . "Attack terminates with vomiting or with eructation."

In five cases reported by me to the Lancet in May and June, 1912, anginous pains and cardiac disorder came into evidence after food taking. In one of these cases no attacks recurred, after deflation of the stomach by the introduction of an œsophageal tube, and after it had been washed out with an alkaline solution. In a person seen by me, who at a subsequent time died in a seizure a few minutes after drinking a pint of hot tea, gastric resonance was found as high as the fifth rib. In him I noticed a symptom which many times previously I had observed in others. When the seizure was subsiding a continuous bubbling stream could be heard passing beneath the chest piece of the stethoscope, placed over the left hypo-chondrium. The patient informed me that he was conscious of a sensation of a passing current of gas, in this situation, and that the sensation was invariably felt in the same region after seizures. Frequently it began

just before the seizure ended; then he welcomed the sensation as a sure sign of approaching relief. Borborygmals at times were sufficiently loud to attract attention of nurses at other parts of the ward. These sounds might have arisen from movements of gas either at the duodeno-jejunal flexure, or at the junction of the transverse with the descending colon.

§1. Gas a prominent symptom of the syndrome

Sir James Goodhart, *Lancet*, July 1st, 1905, writes:—

“Angina pectoris is common among us if we are on the look out for the milder forms of it. In walking up the smallest incline the patient will shy and stop to look into a window. In a few seconds the pain will have vanished with nearly always an eructation of wind, and be regarded as a simple indigestion.”

Dr. Broadbent remarks that flatulent distension of the stomach may bring on attacks of true angina. In the *Lancet*, 1913, he relates several cases where high tympanitic resonance is attended by anginous seizures which ceased when the tympanitic sign of gastric distension had been reduced to its normal limitations. Sir Clifford Allbutt writes in his work on—*Diseases of Arteries*, Vol. 2, p. 442:—

“Dilatation of the stomach by some processes of sympathy or exhaustion may be induced by angina pectoris, it is frequently associated with it. Broadbent and myself made this observation, and so before us did Elsner explicitly. We have noticed that eructation often signifies relief.” “If gastric ectasis is not to be reckoned as a correlated symptom of angina, the co-existence is by no means to be overlooked, as the mere oppression of it may provoke the recurrence of seizures, or even determine the moment of death.”

Sir William Osler relates the case of a patient who died in status anginosus of fourteen days duration—the author noted great gastric distension.

Dr. Mitchell Bruce, speaking of tobacco angina, remarks that after eructation of wind, the attack passes away. Sir Clifford Allbutt referring to this remark adds, “But this it may do in true angina.”—*Diseases of Arteries*, Vol. 2, p. 245.

§I. Gas a prominent symptom of the syndrome

Sir Clifford Allbutt speaks of a patient "who was not beset by any dyspeptic symptoms, who became aware of flatulence at his first seizure which as the seizure passed off rumbled up in enormous quantities. Neither before the seizure, nor during it, had he belched or gulped. His subsequent attacks were marked by the same sequence. After making frequent reference to this symptom Sir Clifford Allbutt states conclusively, "Flatulency has been regarded by all writers on angina pectoris as a general, a pressing, and perhaps, a cardinal factor; but its significance is not easy to interpret."

Sir Clifford Allbutt concludes: "My own observation and those of others prove again and again that attacks of angina, of angina major or minor, often appear without any eructatory effects, yet the wind and the pain may be discharged together. In some cases of angina pectoris, swallowing is in abeyance. Now the suspicion of wind as the enemy is true, not of angina only, it is common to sufferers from almost all cardiac disorders, who suspect some correlation or bond between the wind and the heart's behaviour. Whatever the nexus, whether a vagus reflect from heart to stomach, or a mechanical butting at the heart itself we are not yet in a position to say. Every day experience tells us, that cardio-aortic maladies are mitigated by rules of diet which guard against generation of wind in the stomach and are relieved by cordials which expel it, when there."

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Section 2. *Gas, as a Medium of Initiation, and Sustenance of Seizures, which ends with its escape.*

WHAT explanation can be given for upheavals of §2. Explanation of the gas noticed frequently to occur during anginous gassy symptom. seizures? That anginous subjects possess gassy stomachs and discharge gas in large volumes, during or after seizures is a matter about which no doubt can be entertained. Every writer of authority dwells on the subject.

Sir James Mackenzie, who frequently refers to this symptom in his work on disease of the heart, explains it, upon the hypothesis, that air is swallowed by the subject and afterwards expelled by him. Even if the subject of the seizure do swallow air, the hypothesis does not provide an explanation for processes associated with the presence of gas in the stomach. The really important questions to explain are, not as to how gas gets into the stomach, but when there, how does its presence initiate and sustain seizures, and how comes it to pass that the wind and pain are discharged together. These are questions which we shall now consider.

During normal states of health, much saliva containing air in suspension passes through the gullet into the stomach. When subjective impressions are carefully noted, it is observed, that to refrain from swallowing, for a few successive minutes,

§2. Explanation of the gassy symptom.

requires an effort of will. Indeed saliva and air swallowing are physiological expedients and are essential in the maintenance of healthy function of the alimentary track.

In persons of anginous habit the stomach is intolerant of gas owing to hyper-irritability of its musculature, and eructations are of frequent occurrence, particularly when tonus of the gastric tunic is raised through walking or through mental emotion. A gassy stomach is in reality a contractile stomach.

Expulsion of gas furnishes evidence of high intragastric pressure. It has been noticed, time and time again by those who practise radioscopy, that persons of flatulent habit are not necessarily subjects of dilated stomach, as formerly they were supposed to be, but conversely, their stomachs are small and contractile. In one such case under rontgen rays I noticed that almost immediately after the bismuth meal had been swallowed it was ejected in its entirety through the pyloric orifice. In four out of five cases of angina pectoris, submitted by me to Rontgen Ray examination, stomachs were hyper-irritable and refused to entertain the bismuth meal, for any reasonable length of time. A similar contractile state of the gastric wall has frequently been noticed by me in hysteria, and among persons of confirmed tobacco habit.

Here then we find solid ground, upon which to base a tenable hypothesis. The gassy stomach possesses a hyper-sensitive, hyper-irritable, muscular tunic, a condition which indicates a state of abnormal sensibility of segmentary

centres. Consequently, in it when intra-gastric pressure is raised, even to inconsiderable degrees of elevation, hyper-tonus occurs and discomfortable sensations merging into pain are felt. Starling has shown that both œsophageal and pyloric orifices are closed, when vagi are subjected to irritation.

§2. Explanation of the gassy symptom.

With these facts before us, we are in a position to form an opinion as to what actually occurs in the stomach of the anginous subject, when intra-gastric pressure is raised. In the first instance, orifices of entrance and exit are shut and solid and gaseous contents remain imprisoned. Secondly contractions of muscular tunic occur and pain is felt.

Here we find an explanation for the initiation of the anginous seizure and for its sustenance. Gas is a passive medium, not a kinetic force, and gas opposes resistance to the contracting muscular tunic. As long as gas, at high pressure, remains imprisoned in the organ, so long hyper-tonus of the tunic continues to rise and so long pain remains intensive. But when this medium of resistance escapes, either through pylorus or by way of œsophagus, hypertonic impulses languish and pain comes to an end. A similar sequence of events occurs, during acts of simple vomiting. When the full stomach has discharged its contents and resistance to contraction ceases, distress attending the expulsatory impulse vanishes.

Just as cardio-inhibitory and vaso-motor phenomena result from hypertonus of the muscular tunic of the stomach

§2. Explanation of the gassy symptom. in simple vomiting attacks; so in anginous seizures when these phenomena occur they are to be regarded as the product of the same agency.

It is not a great volume of gas residual in the stomach which makes the gassy habit, but intolerance on the part of the muscular tunic which opposes the entertainment of gas.

During February, March, April and May, 1912, one hundred observations were made by Dr. X. on the associated conditions of flatulence and pain. The record of occurrences of these phenomena was taken soon after walking up a flight of stairs to his bedroom, at, or about eleven o'clock p.m. He was in the habit of seating himself in a chair immediately after he had reached his room; then winding up his watch, and, watch in hand, he noted the time when the first sensation of discomfort was felt.

Records taken are divisible under five heads. (1) In eleven instances, no eructations occurred, nor was discomfort nor pain felt. (2) In nine instances gas was eructated, but the phenomenon was not attended, either by discomfort or pain. (3) In forty-five instances no actual pain was felt, but eructation was associated with discomfort, consisting of discomfortable sensations of pressure chiefly felt in the region of the synchondrosis, and deep sensations resembling such as might be felt from the lodgment of a large bolus of food in the gullet. In every instance the discomfortable sensation vanished immediately after gas had been expelled from the chest. (4) In the fourth category are found instances in which actual pain of varying degrees of intensity followed discomfortable sensations. Discomfort attended by œsophageal sensations referred to above, came first in order of time and pain followed. Discomfort merged into pain through rising gradients of intensivity. It was impossible to

mark the scintilla of time when the one sensation ended and the other began. Yet in an analysis of the period of transition from one kind of sensation to another, usually lasting about thirty seconds, great changes were found to be in progress. At the end of the period the distinctive feeling of "globus" had vanished, and though sensations of discomfort were present, their culminating point was on the left side, generally near the sternal border or in the line of the anterior axillary fold, and in tributary regions of 2nd, 3rd and 4th intercostal nerves. If the attack lasted for a sufficient length of time, the painful area widened, pain radiating to one or both shoulders and arms. Twenty-eight instances of mergence of discomfort into pain are recorded. In every instance pain began to subside immediately after gas had found vent. (5) In seven instances pain came on while Dr. X. was still on the stairs before he had reached his bedroom.

§2. Explanation of the gassy symptom.

In every instance in which pain was felt, gas had failed previously to find vent from the stomach in any considerable quantity. In all attacks the end was accompanied by explosions of gas. Discomfort usually appeared sixty to one hundred and eighty seconds after Dr. X. had seated himself in his bedroom, not immediately after exercise which induced it, had been taken. The stomach was seldom deflated through a single eructation, generally a number of belchings, each giving vent to small quantities of gas, were followed by a final and prolonged expulsion, during which a large volume was expelled. In innumerable unrecorded instances occurring during the last twelve years, Dr. X. has noted relief from pain to follow eructation of gas during attacks excited by walking.

In reference to experiments made by Dr. Hertz we notice that when intra-gastric pressure is raised to 12 mm. hydrarg, sensations of pressure are felt, and a desire to eructate gas comes into consciousness. If intra-gastric pressure be increased to higher levels, primary gastric sensations merge into pain. It was also noticed that intra-gastric pressure, determines contraction of the muscular tunic and synchronously with this event, gastric sensations come into being. These experiments performed upon healthy adults explain the nature of similar symptoms witnessed in the anginous subject.

The muscular tunic is the sensory organ of the stomach and gastric sensations are produced through hyper-tonus of the muscular tunic; by this means and through no other agency whatsoever.

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Section 3. *Bubbling Slime.*

§3. Bubbling
slime.

IN the Chapter on treatment, Section 8, reference is made to cases in which deflation of the stomach was practised by instrumental means; a practice followed by instant relief from anginous pain and from symptoms attending it. No evidence more conclusive than this can be asked for, in support of the contention that the gastro-oesophageal portion

of the alimentary canal is the agency of pain in the anginous seizure and that gas is an efficient medium in its production. §3. Bubbling slime.

A question of importance relative to this mode of ending a seizure, is suggested by occasional blockages of the channel of the tube with frothy mucous. The frequency of the accident leads us to ask whether gas residual in the stomach is free, or is the bulk of it imprisoned in bubbles of foaming slime? Much can be said in favour of the second view. When anginous pain is felt, persons, even those proficient in the art of belching, not infrequently find difficulty in expelling imprisoned gas from the stomach; a difficulty often overcome by taking peppermint, soda, sal-volatile, or other medicines enjoying a reputation for liberation of flatus.

In many instances I have noticed voluminous eructations of gas and the sudden ending of attacks to follow a few minutes after administration of 30 grains of bi-carbonate of soda in half a tumblerful of hot water. On occasion, I have noticed the spongy and yeasty character of matter vomited by anginous subjects. It is suggested that gastric plasmodia are disintegrated by the solvent properties of the alkalies and gas is set free. The explanation is a common one that gas evolved in these cases, results from effervescence, set up through introduction of carbonates into an acid stomach; but the phenomenon occurs with equal frequency even in cases where the contents of the stomach had, previously and later, shown a lack of acid, rather than a surplusage.

Let us infer that vegetation, such as that produced by the yeast plant, is actually in being in stomachs of

§3. Bubbling anginous subjects. The character of vomited matter justifies this inference. Imprisonment of gas in bubbles of mucoid slime is a bar against expulsion. The plasmodium is lessened in bulk with every contractile effort of the muscular tunic, but its former proportions are regained instantly, and as soon as contractile energy is relaxed. Myoblasts of the tunic and neuro-blasts of the segmentary centre, thwarted in expulsatory purpose at every turn, grow angry and fall into inco-ordinate and spasmodic action. Influenced by this view we are able to understand the part played by gas in the production of segmentary neurosis and in the formation and perpetuation of the anginous habit.

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Chapter V.

Description of Anginous Symptoms ; Spasm.

Section 1. Spasm and Rigidity of Parietal Muscle.

Section 2. Hypertonus of Visceral Muscle.

Section 1. *Spasm and Rigidity of Parietal Muscle.*

GROUPS of muscles involved in spasm during §1. Spasm of
anginous seizures and in rigidity during intervals ^{parietal} muscle.

between them, are located in face, neck, shoulders, and in thoracic and abdominal walls. In this category, on rare occasions, brachial, diaphragmatic, and laryngeal muscle is included. In a single instance under my notice spasm occurred in adductors of the great toes and in another case, on the approach of an attack, muscles of shoulders and arms were convulsed with clonic spasms. In order of frequency of muscles affected, recti-adominis hold the first place, and intercostals the second.

§1. Spasm of
parietal
muscle.

Spasm of facial muscle is described by many writers under the designation of the "Risus Sardonius." Retractors of corners of the mouth are chiefly affected. In one instance under my notice, spasm in this region was clonic. Tetany of muscles of the trunk is not uncommon in cases of infantile hypertrophy of pylorus. In developmental history, facial muscle is closely associated with musculature of the alimentary canal, and during infantile life a convulsive spasm of the latter sheet excites reflex contortion of the features.

Spasm and rigidity of sternomastoid and intercostal muscle favour transmission of sounds and impulses. It is probable that rigidity of tensor tympani accompanies a similar state in sterno-mastoid muscle. In certain anginous seizures cardiac sounds are heard and impulses are felt by the subject himself. At intervals between seizures when the head is resting on the pillow, sleep is delayed through aggressiveness of these subjective impressions. When cardiac impulses are strong the skull has been known to rock on its bony axis with every beat. When recti-abdominis muscles are contemporaneously affected, cardiac sounds and impulses travel downwards as well as upwards. I have objectively felt these impulses and heard through the stethoscope these sounds at the horizontal plane of the umbilicus and I have seen the lump formed by a rigid rectus, throb like a pulsating growth or like an aneurism. The diaphragm sometimes participates in the general spasmodic condition and then breathing is restrained, and loses its abdominal feature. I take it that no proper line of differentiation can be drawn

between angina abdominis and angina verum, the former type frequently merging into the latter. The same ratio of mortality attends both.

§1. Spasm of parietal muscle.

When abdominal symptoms are prominent, diaphragm is usually rigid. On the contrary however sometimes the diaphragm is atonic. In a case of viscero-ptosis, subject to anginous seizures this condition was present and gave a strange turn to symptoms. At every inspiration the flaccid diaphragm was sucked upwards, and contemporaneously abdominal walls instead of rising sank, forming a concavity just below the arch of the ribs. Owing to paresis of the diaphragm intra-thoracic minus pressure lost aspiratory force, auricles ceased to expand fully, breathing was embarrassed and a purple tinct suffused face, ears, and hands. Certain anginous subjects ascribe the lump formed by a spasmodic rectus to an accumulation of gas and for this reason. When the lump is rubbed vigorously it vanishes and gas is simultaneously expelled from the chest. That gas is eructated and that the lump subsides synchronously under this method of treatment is true, for I have witnessed the practice and noted the result in several instances. Nevertheless having carefully examined these lumps I recognise their spasmodic origin and muscular nature. In lean subjects heads of attachment of the recti to lower ribs are seen standing out in bold relief.

In a single case observed by me, clonic spasms of a painless character occurred in groups of muscles of shoulders, arms and neck. Attacks usually occurred at night and awoke the patient from sleep. Spasm began about ten or fifteen minutes before he was disturbed by pain, and about one hour after he had gone to sleep; at first gently,

§1. Spasm of parietal muscle. afterwards with sufficient violence to shake the bed. Muscles of the face twitched, and shoulders were raised and depressed; these latter movements alternating in rapid succession. When pain, described as of a bursting character, at length roused the patient from sleep he sat up in bed and retched. Borborygmal sounds could be heard across the room, and he heaved up gas in great quantity. He could not swallow, and once on taking a glass in his hand, spasm came on, and it was thrown some distance from the bedside. Clonic spasms usually left him when he was aroused from sleep by pain, but sometimes, as in the case of the incident mentioned, they returned. After borborygmal sounds had been heard, and after much gas has been thrown from the chest, seizures suddenly subsided. They ceased to recur at night after the patient had relinquished the habit of taking milk for supper. One day, about three weeks after night seizures had ceased, an attack of angina came on and killed him.

All writers on the subject refer to spasmodic symptoms. Sir Douglas Powell writes:—"That patients feel a sense of constriction as if the heart were gripped or the thorax were severely pressed." Ross, in "Brain," Vol. 10, p. 355, speaks of persons during seizures feeling great tightness over the ribs. Bristow in his work, referring to this symptom says:—"Pain is generally attended by a sense of constriction." Balfour writes:—"Pain associated with a sense of constriction as if a mailed hand grasped the chest." Sir James Mackenzie frequently returning to the subject in his work on "Diseases of the Heart," writes:—"Some would limit the term angina pectoris to that class of cases where, in addition to the pain, there is a sense of constriction in the chest amounting to the sensation, at times, as if the chest were gripped in a vice. I am convinced," writes he, "that these sensations arise from spasms of the intercostal muscles."

In many cases I have failed to discover, even after careful search, either spasm or rigidity. It may be suggested that these processes when occurring in intercostal muscle are difficult to discover or impossible. While admitting that neither spasm nor rigidity reveals itself through tests of palpation or inspection, its presence is disclosed by discomfortable feelings of tightness or stiffness of thoracic walls,

or through exaggerations or extensions of cardiac impulses and cardiac sounds. But since these signs are as certainly wanting in some cases, as assuredly they are present in others, I think it must be concluded that spasm and rigidity are not constant features; at least as far as parietal groups of muscles are concerned. But inconstancy in the matter of spasmodic symptoms is not a subject for surprise. Constancy is not of the essence of angina pectoris. Indeed no symptom in the syndrome is universally in evidence, not even pain itself; for is there not a type of this complaint which goes under the name of "angina sine doloris." The ephemeral nature of algesia, which comes into a distributary zone, and remains in evidence for a time, and which disappears to reappear in another place, is evidence that the neurosis itself shifts its ground with every wind that blows.

Section 2. *Hyper-tonus of Visceral Muscle.*

IN the last chapter, the statement appears that gassy §2. Hyper-
eructations, a common symptom among persons of tonus of
anginous habit, results from hyper-tonus of the visceral
muscular tunic and this statement is confirmed by radio-
scopic examinations, consequently during anginous seizures
when gastric symptoms are found occurring contemporaneously
muscle.

§2. Hyper-
tonus of
visceral
muscle.

with spasm and rigidity of intercostal, diaphragmatic and recti abdominis muscles, we recognise in it, an example of dual reflex contractile activities between visceral and parietal layers. This is a mark which distinguishes reflex phenomena witnessed in members of the class of paroxysmal spasmodic disorders associated with the musculature of the alimentary canal, to which class we regard the angina pectoris as belonging. For further information on this subject the reader is referred to Chapter XI. on classification and to Appendix 1 on protective reflex phenomena.

Dual contractions in visceral and parietal layers of muscle attended by agonising pain are sure marks of segmentary neurosis.

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Part II. Etiology.

Chapter VI.

Significance of Cardiac Disorder.

- Section 1. Cause of Sudden Death in Anginous Subjects.
- Section 2. Arrhythmia.
- Section 3. Frequently during Seizures the Heart remains undisturbed.
- Section 4. Exhaustion of Myocardial Contractile Energy is not the cause of Seizures.
- Section 5. Coronary Disease is not the Basis of Anginous Habit.
- Section 6. Aortic Disease, although a Potential Causal Agent of segmentary Neurosis, is not the Predisposing, nor yet the exciting Cause of Seizures.
- Section 7. Significance of High Blood Pressure.
- Section 8. Dyspnœa and Orthopnœa.
- Section 9. Summary of Reasons against the Doctrine that Anginous seizures result from a Myocardial Reflex.

Section 1. *Cause of Sudden Death in Anginous Subjects.*

DEATH from angina pectoris usually occurs without any warning note, and unattended by signs, which commonly accompany seizures. At the moment before arrest of function, the pulse may be strong and its rhythm regular. Often death occurs during sleep, in which

§1. Cause of sudden death.

§1. Cause of sudden death

case the pose of the body is not suggestive of any antecedent struggle.

Evidence has been adduced by Sir Clifford Allbutt to show that the heart is stilled and death results, not from a cause inherent in the myocardium, but from vagal inhibition.

Much can be said in support of this view. Experimentally, hyper-irritability of vagal centres can be induced through an administration of digitalis, and when this drug is taken over a prolonged period, inhibition is readily excited. In one such case Sir James Mackenzie noticed that swallowing arrested cardiac action, and in instrumental tracings, a concurrent break in jugular and radial curves was recorded.

In the angina pectoris a similar phenomenon is noticed. In the case of Mrs. D., who died suddenly in bed without a struggle, ephemeral arrest of cardiac function during intervals between seizures, was of frequent occurrence, but although many synchronous tracings of jugular and radial pulses were taken during seizures occurring in her last illness, I only once found this trope breaking the even tenour of the curve.

Infrequency of death during seizures, that is to say when pain is at its height, is a subject of remark. I think the paradox can be accounted for on the grounds that activity of sympathetic centres, inhibits activity of vagal centres. In the case of cerebro-spinal nerves, contractile and extensile movements are mutually inhibitive. It is noticed also in the case of the myocardium, muscle during systole is refractile to ordinary inhibitory impulses. From these facts it is argued that vagal action is inhibited by strong splanchnic

action which attends seizures, and which is responsible for characteristic symptoms, such as spasm of intercostal and gastro œsophageal muscle, and such as referred pain. If this be so, pain can be regarded as an expression of a sympathetic process, the purpose of which process is inhibition of the prime inhibitor.

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Section 2. *Arrhythmia.*

A FORM of cardiac arrhythmia, more common than §2. *Arrhythmia.* any other in persons of the anginous habit is extra systole, but extra systole is a form of abnormal deflexion, frequent among persons suffering from gassy and overburdened stomachs, particularly among such persons as are of a neurasthenic type. Persons there are who cannot take a cup of tea without afterwards being conscious of this irregularity. A dish of salmon and cucumber excites it in some, a cup of hot milk at bed time, a mince pie, or a jam roll, in others. It often intervenes and alarms persons during attacks of palpitation induced through errors of diet. I have known instances of persons awaking early in the morning, who hear pulsation in their ears, broken by numerous extra systoles, and more than once such persons

§2. Arrhythmia. have told me that the arrhythmia has been dispelled by getting on to their feet and by throwing gas from their chests.

In anginous subjects, a strange feature for which I know not how to account, is the disappearance of the extra systolic trope during the span of time occupied by the seizure. On more than one occasion I have been engaged in taking cardiographic records in a person habituated to extra systolic phenomena, and no sooner did the pain begin than the curve became quite even; but with lapse of pain, the arrhythmia reappeared. Nevertheless, in anginous seizures excited by walking, pain and extra systoles not infrequently come together. Not infrequently, during seizures the pulse grows small and compressible, and on this account, difficulty may be experienced in registering the beats. This latter phase is more marked when the subject of the attack is walking, than when he rests; and when the weather is cold rather than when it is warm. Dorsal veins of the hand usually full and round at normal times, are now empty and thread-like.

On a single occasion only while taking a tracing during a seizure, a momentary cessation of movement in jugular and radial pulsation was noticed to occur. The lapse extended over the space occupied by three normal cardiac cycles.

In a case of angina, attacks of auricular fibrillation were occasionally observed. Certain of these were attended by pain; but in certain pain was absent. In one case in which death occurred as a result of progressive cardiac failure, pulsus alteranus was a marked feature. In cases coming

under my own personal observation, dyspnœa has been a most uncommon symptom, and œdema of the lower extremities when present has been found to result from a surcharged colon, and has disappeared when feces gathering in it had been expelled.

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Section 3. *Frequently during Seizures the Heart remains undisturbed.*

CONTEMPORANEOUS tracings of jugular and §3. During seizures heart radial pulses, beginning before the seizure had undisturbed, commenced, and ending after it was over, have frequently been taken by me, yet the greater number of them manifest no disturbing feature in the curve. In forty-five out of seventy-two instances, observations made during seizures disclosed no fault in radial, nor in jugular pulsations. In the rest of the series unimportant changes only occurred, and these related to inconsiderable changes in beat rate, calibre and compressibility.

In this connection Heberden's remarks are significant. "The pulse is, at least, sometimes not disturbed by the pain, as I have had opportunities of observing by feeling the pulse during the paroxysm," and further referring to the general condition of anginous subjects he says:—"Patients are at the beginning of this disorder perfectly

§3. During
seizures heart
undisturbed.

well, and in particular, have no shortness of breath from which it is totally different." Upon the absence of cardiac disturbance, Sir Clifford Allbutt, in his great work, has introduced much evidence drawn from many sources. He says:—"In death from angina pectoris the state of the heart, whether normal or abnormal, is not constant."

Upon the practice of auscultation in a case during a severe paroxysm, Lathom found "the heart beating with a perfect rhythm, and neither with excess nor defect of impulse, and its sounds were natural." Walsh says:—"In the very extremity of pain the pulse may be perfectly regular and barely exceed by half a dozen beats per minute, the rate normal to the individual." Eulburg and Guttman, who carefully noted this point, found the action of the heart and pulse, except for occasional slight irregularities, to be normal all through attacks. They felt assured that the explanation of attacks could not lie in alteration of the heart's action. Edgren reported, after examination of many cases, "curiously, the heart seems quite quiet and just as in the intervals of pain."

Leyden testifies emphatically that auscultation furnishes plenty of evidence that during attacks changes in the sounds and pulsation are rarely observed. Dieulefoy wrote:—"During the attack, auscultation reveals no abnormal sound, the heart beats are normal or retarded." Josue states:—"One finds on auscultation the same condition during attacks as during the intervals, there is no change in any particular."

Sir James Goodhart writes:—"That as a rule the pulse is wholly unaffected, either in rate or in rhythm, or in tension; having had my finger on it through the spasm many a time, and yet he exclaims we call it heart disease, why for the life of me I cannot imagine, these are not the symptoms of heart disease, the heart has too much grit in it to tumble down dead, except under well known and definite conditions."

In one instance, Goodhart carefully watched a series of paroxysms lasting half-an-hour, and reports:—"His pulse never altered a bit." Of another case, he says:—"The pulse never altered, nor faltered in any way; from the pulse you can get no indication of the gravity of the attack of any value." Reporting on yet another case, Dr. Goodhart says:—"The heart was to all means of examination perfectly healthy, and upon a second examination I made this note—If he went to an insurance office and said nothing he would be passed as perfectly sound." Sir Clifford Allbutt concludes by remarking:—"We do not realise what these large admissions mean."

"In a vast majority of cases," Sir James Mackenzie writes:—"I could detect no change in the heart nor arteries, and there never was the slightest enlargement of the heart coming on during attack." In despair of finding a solution of the anginous problem, he concludes by saying:—"I admit I have no definite idea of the state of the heart during the paroxysms."—*Disease of the Heart*, p. 304.

Of course the rule that the heart retains its normal activities during seizures has many exceptions, among which are included those cases in which the heart is a subject of disease and under stress, of whatsoever kind it be, acts irregularly. On this point Sir Douglas Powell writes:—

"Adventitious sounds, such as murmurs, may or may not be present, but they have no natural relation to the anginal paroxysm." In the *Lancet*, June 29th, 1901, he writes:—"In many cases angina pectoris is dependent upon a disorderly action of the vaso motor nerves, and is associated with a sound heart."

Functions of the heart are frequently disturbed when seizures are excited by strenuous exercise or by emotiona

§3. During seizures heart undisturbed.

§3. During
seizures heart
undisturbed.

disturbance ; whereas, in the same persons, seizures occurring during profound physical and mental rest are not as frequently attended by cardiac disorder.

In the case of Dr. X., I have made observations on the condition of the heart during seizures, starting without any apparent provocation, during seizures induced by food taking, during seizures following defecation, and also during seizures excited by walking, or through emotional disturbance. In the case of Dr. X., it is a rule, with few exceptions, that seizures provoked by muscular exercise or by mental excitement are alone attended by cardiac disturbances.

After fifty or sixty paces have been taken, frequency in pulse rate increases by fifteen to twenty-five pulsations per minute, and when walking is persisted in, cardiac action becomes weak and irregular, and at the same time a feeling of pressure is noticed in "epigastric" and thoracic regions, which afterwards merges into intercostal pain. Œsophageal sensations are also felt, suggestive of impaction of food in the gullet. Precisely the same order of events occur when Dr. X. engages in an exciting argument, while sitting at table after meals. Different are seizures invoked by going to stool, by eating, and in those starting at times of physical and mental quiescence. In these latter named instances, with exceptions not numerous, the heart continues to pursue an even course.

"How is it," writes Sir Clifford Allbutt,—*Diseases of Arteries*, p. 466 :—"That an attack of pain kills suddenly, and by a heart stroke, although time after time physicians have watched the invasion to the very door of death without a totter of the heart ; or with no more perturbation of it than is seen in many a transitory disorder, which, apart from the signals of angina, would not give us even momentary

alarm? Is it not still more incomprehensible that often while the patient is in so hard a grip that he cannot start back, even from death's door; his pulse may be going on its way with indifference, and not be moved even with a secondary and sympathetic affection."

§3. During seizures heart undisturbed.

Observations on myocardial action during seizures reveal no sign of impairment of the five function of Gaskell. Precise methods of cardiographic record recently introduced by Sir James Mackenzie, and employed in research, furnish proof that during paroxysms of angina pectoris, myocardial functions of Gaskell are working after a normal manner. Hence hypotheses based upon the doctrine of claudication and coronary and cardiac spasm are untenable.

The truth of this statement is confirmed in certain observations made by me.

In one particular case I took eighteen contemporaneous tracings of radial and jugular pulses during seizures. The case was one of a spinster lady, who at the time when this series of tracings were taken, was suffering from a sequence of attacks following each other at short intervals. Attacks were induced by food taking, by pressure over the right or left rectus abdominis muscle, and by pressure over brachial nerves, such as that imposed by the adjustment and inflation of the cuff of the manometer. Since I was in frequent attendance upon this lady for three or four years, and as seasons of frequency of seizures occurred at menstrual periods, material for observation was ample.

Whether seizures were excited by walking, by food taking, by pressure over abdomen or brachial nerves, the mode of their initiation was much the same. In all instances they began with a sensation of discomfort, attended by nausea seated deep in the chest cavity beneath the left sixth costo-chondroid articulation. Discomfort merged into pain, and pain diffused itself over retro-sternal and retro-costal bilateral regions. On account of its widespread character, which, soon after its initiation, defied limitation by anatomical boundaries, its precise localization was impossible. At times it attacked the back, the jaws, the neck, the shoulders, and the arms. Attacks usually lasted three or four minutes. In all examples, deflections of radial and jugular curves were perfectly timed and accurately formed. V., A. and C. waves were well defined. X. and Y. depressions were of appropriate depth, and cardiac cycles were evenly spaced. Functions of excitability, contractility, conductivity, tonicity and stimulus production, showed no sign of abnormality in graphic records.

In the case of Mrs. D., a married lady, who died during a seizure, a peculiar alteration in beat rate was noticed.

The normal standard of beat frequency was at seventy-two. When discomfort heralding the approaching attack was felt, frequency of beat rate was wont to leap at one bound to one hundred and forty-four, to remain at that figure until pain ceased, and then to fall back instantly to the normal standard rate. On occasions, however, a converse order of frequency obtained, pulse rate falling as low as twenty-four. But whether frequency rose or fell, it moved in multiples of twelve. During these observations in no instance did signs appear of impairment of function of cardiac muscle.

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Section 4. *Exhaustion of Myocardial Contractile Energy is not the cause of Anginous Seizures.*

§4. Anginous seizures not caused by exhausted contractile energy.

CERTAIN writers suggest that seizures are due to loss of reserve energy of the contractile function, a condition which manifests no appreciable mark on the pulse. They liken anginous pain to that felt in muscle exhaustion through excessive effort. But it can be argued that pain generated in exhausted visceral muscle, does not arise from lack of contractile energy, but through hyper-irritability of segmentary centres and from muscle sense impressions resulting from irregular spasmodic contractions.

In fifty cases of enlarged fatty and otherwise flabby hearts collected by me, muscular effort, although producing distress of breathing and embarrassment of myocardial action, did not induce pain. In the relaxed and exhausted uterus, pain is not felt except the wall be undergoing irregular sectional spasm.

During intervals between contractile rigours, the tired intestine manifests no painful symptoms. If the heart determine pain during states of exhausted contractile energy, in support of which hypothesis no convincing evidence has ever been given, it is a symptomatic expression which has no parallel in other hollow visceral organs.

§4. Anginous seizures not caused by exhausted contractile energy.

Dilatation of the heart, although a sign of loss of tonus and hence a loss of contractile energy, is not commonly attended by pain. In his Lumlean lectures of March 10th, 1894, Dr. Samuel West, remarking on absence of acute pain in cases of chronic enlargement, says:—"Cardiac pain of an acute kind at all resembling angina is very rare."

Sir Clifford Allbutt—*Diseases of Arteries*, v. 2. p. 387, says:—"General experience is that the heart is liable to be far more dilated and more suddenly dilated, whether on the right side or the left, in disorders and stresses other than angina and this without any considerable pain. While inversely in angina dilatation of the heart, whether we look to the cardiac physical signs or to the secondary evidence of other organs, is not a considerable feature. We often meet with extreme dilatation, as for instance in infectious myocarditis, with no pain. There is no approach to a parallel between cardiac dilatation and cardiac pain, and when we do find dilatation and pain together, the pain is not characteristically anginal."

The suggestion made by Sir James Mackenzie, namely, that referred anginous pain, springs from failure of reserve of contractile energy to meet circulatory requirements, does not receive support from evidence furnished by cases such as the one reported by me to the *Lancet* of April 3rd, 1915:—

The patient, aged forty-eight years, had always had good health, except in the matter of his digestion. Sweet foods turned sour on his stomach and distended it with gas. He was a "windy" subject, but

§4. Anginous seizures not caused by exhausted contractile energy. looked robust and in good flesh. A few weeks before visiting me he became conscious of a disability which seemed likely to prevent him from following his occupation : for when he walked, particularly if soon after eating, he was seized with a most disagreeable sensation in the chest, merging into pain. No evidence of cardiac disease was detected. There was no increase in the area of cardiac dulness, no abnormal cardiac sounds, dyspnœa, or œdema, no abnormality in pulse-rate or rhythm. About five weeks after this examination, and after a hearty afternoon meal, the patient left the house. When about two hundred yards from his own door he fell down and was picked up dead. No lesion accounting for death was found at the necropsy. All his organs were healthy. The cardiac valves were normal, and the myocardium thick and free from disease. Coronary arteries were sound, save for one or two small foci of commencing ossification. Their pathological condition was such as might be expected in persons dying at the same age from indifferent complaints.

The manner in which seizures affected this patient is thus described in his own words :—

When I leave home in the morning I usually feel quite well, but after walking one hundred paces or more I am conscious of an uncomfortable sensation at the stomach and a desire to expel gas from the chest. I have also a feeling as if a piece of crust had become lodged in my gullet, pain creeps up from the pit of the stomach to the chest and spreads all over it, sometimes reaching the armpits, shoulders and back, and even extending to the neck and jaws. Water gathers in my mouth and runs out upon my chin : it is neither retched nor coughed up, but comes into my mouth on its own. My eyes fill with tears; sometimes urine dribbles away from the bladder in spite of my efforts to prevent its escape. If at this time I can break wind from the chest, all this discomfort vanishes in a second. So every now and then I stop and retch and throw gas from my chest, and when all is thrown off I can walk as well and as far as I ever did before. But sometimes the gas is hard and will not come up, and then a dreadful feeling comes over me; it is as if my head swims and my chest is gripped and held tight, and all strength is going from my limbs, but even when no gas comes up, if I stop walking and remain for a few seconds standing still, the seizure passes off.

When asked what distance he had walked upon any occasion just after occurrence of seizures, the patient said :—

“On Bank Holiday, soon after starting from home in the morning, I was taken with a seizure which was followed by two others, but after I had stood still for a few seconds and broken up wind, I walked on without having to stop again, and visited a friend living five miles away. That morning I walked ten miles, counting the journey there and back again, without being troubled with any pain whatsoever; indeed, I never felt better in all my life than during that walk.”*

* The fact that the patient walked ten miles just after several seizures, indicates that exhaustion of reserve power of the function of contractibility is not the causal agency of these seizures.

Cases in which long walks are taken after seizures are not infrequent. Dr. Mackenzie refers to cases of this kind in the Oliver-Sharpey lectures.

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Section 5. *Coronary Disease is not the basis of Anginous Habit.*

ON this subject Sir Clifford Allbutt quotes from the §5. Coronary disease not the basis of anginous habit.
 writings of many Authorities, a selection from these citations is here given as a prelude to statistical evidence which when taken together with it I deem conclusive.

Desportes says that having examined many bodies of persons over 50 years of age, he found coronary atheroma at least as common in women as in men, yet in women angina is rare. Cohnheim writes "often no trace of disease is to be found in the coronary arteries of subjects of angina" much the same opinion is expressed by Frankel "Angina arises in other heart diseases, for instance in certain valvular affections and under conditions where the coronary arteries are intact throughout." Hirsch freely admits that most cases of coronary sclerosis take the form of chronic heart insufficiency, without any symptoms of angina. Thorel writes "life is often prolonged with both coronary arteries closed, yet without angina." Dr. Samuel West reports a case in which one coronary was completely obliterated and the orifice of the other so minute that no blood could have

§ 5. Coronary disease not the basis of anginous habit.

traversed them to the heart, yet without angina. Balfour writes coronary sclerosis is too often present when there has never been any angina to permit the occurrence being looked upon as anything more than accidental. In the large majority of his cases of coronary disease, Wright like West, found no history of angina. Dr. Graham Steill concludes "Angina may be met with apart from any lesion of the coronaries. Morgan in surveying the literature of angina says that whereas coronary disease is found in many cases, yet true angina may occur in patients who are entirely free from disease of the heart. Hoffmann says he has "often observed after years of the severest attacks of angina pectoris" that the necropsy did not show the slightest change in the coronary arteries." In a case of syphilitic angina published by Dr. Morison the coronary arteries, although in the abnormal position and somewhat small, were not diseased. Sir Wm. Osler quotes three cases of typical angina, in each of which the coronary arteries and their orifices were unaffected. Von Seyden admits, that angina may occur without any coronary disease and especially cites cases of syphilis and some other infections to this effect. Cohnheim says as to the "Casual relationship of angina with coronary disease often there is no trace of disease to be found in the coronary arteries of such subjects, and what is more common, very high degrees of coronary sclerosis are met with in persons who have never had an attack of angina."

Sir Clifford concludes his remarkable evidence against the doctrine of the coronary causation of the angina pectoris with the remark—"Such is the testimony of no very favourable witnesses to the not infrequent absence of coronary disease even in mortal cases of angina." "That disease of the coronary arteries does not set up angina, is an axiom founded on universal experience."

If coronary disease¹ be either the predisposing or the exciting cause, statistics from the post mortem table might be expected to show either that this disease is universal, or at least it is far more prevalent in anginous subjects, than in subjects of any other class of circulatory disease. Statistics should also show that at age periods, at which the angina pectoris claims the greatest number of victims, coronary disease is more prevalent, that at age periods of life when victims are few. In both instances statistical evidence is adverse to the coronary theory of causation.

§5. Coronary disease not the basis of anginous habit.

On these points I gave some particulars in an article which appeared in the British Medical Journal of March 18th, 1911.

In a long list of autopsies, namely, two hundred and eighty-three cases, collected by me from the works of Tacchi, Sir John Forbes, Potain, Gothair, Huchard, and Osler, it is ascertained that coronary disease is present in 50·1 instances, and that it is absent in 49·9 cases on the list. Since this evidence might not have been regarded as conclusive by those who hold the Jennerian doctrine in veneration as a creed, I adduced further evidence in the same direction. I compared the coronary statistics of the angina pectoris with those taken from a series of non-anginous cases, dying from indifferent complaints, whose visceral systems showed any sign of arterial disease whatsoever. Dr. Harlow Brooks, Assistant Professor of Pathology, Bellevue Hospital and University, New York, had already collected a list of cases with no reference to angina, but which served my purpose. These cases are described as coming under his notice consecutively in the ordinary course of his necropsial duties, the average age period being forty-five years. In this list of three hundred

§5. Coronary disease not the basis of anginous habit.

and ninety-eight cases, Brooks observed two hundred and seventy instances of coronary disease representing a ratio equal to 73·3 per cent.—Brooks' *American Journal of Medical Science*, May, 1905, p. 781. From a comparison between the list of anginous cases collected by me and the list of indifferent complaints collected by Brooks, only one conclusion can be drawn, namely, that the prevalence of coronary disease in angina pectoris does not exceed that found in other classes of circulatory diseases. Brooks states that of all visceral arteries, except the aorta, coronaries are more frequently affected than any other, and that in aged persons coronary disease is almost universal.

There is another reason why coronary disease is inadmissible as the causal agency of the angina pectoris. If coronary disease be a predisposing or exciting cause, the death incidence of angina pectoris might be expected to increase annually after sixty years of age when year by year coronary disease is bounding upwards. But, just in those years of life when in accordance with the generally accepted hypothesis, angina should be attaining greater prevalence year by year; year by year it marks a rapid decline. Osler gives the age periods of mortality from angina pectoris; I quote from his Lumlean lectures on the subject.

“There were under thirty years of age, nine cases; between thirty and forty, forty-one cases; between forty and fifty, fifty-nine cases; between fifty and sixty, eighty-one cases; between sixty and seventy, sixty-two cases; between seventy and eighty, thirteen cases; above eighty, three cases.”

Herein it is observed that during age periods at which the incidence of coronary disease is increasing until universality is attained, conversely mortality from the angina pectoris is declining until nullity is reached.

I note with satisfaction that Sir Clifford Allbutt's figures on the prevalence of coronary disease in aged persons, although gathered from other sources, correspond with mine, for he says:—"These vessels are atheromatous in at least three-quarters of the bodies which are found after death to be atheromatous at all. Indeed, few elderly persons die without as much coronary disease as would content a coronarian disputant, yet angina is one of the rarer diseases." *Diseases of Arteries*, Vol. 2, p. 380.

It is thus gathered from statistical evidence that the effect of coronary disease, on the causation of the angina pectoris, is nil, nevertheless its influence in determining a fatal issue when angina is present is great; a myocardium impoverished through the attenuation of its nutrient supply soon falls victim to vagal inhibition. A vigorous heart recovers from a blow aimed at its vitality from vagus centres, but the impoverished ventricle stumbles, and unable to recover itself, falls, never to rise again.

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Section 6. *Disease of Aorta, although a Causal Agency of the Segmentary Neurosis, is not the Predisposing, nor yet the Exciting Cause of Seizures.*

IN paroxysmal spasmodic disorders a tendency to confound the predisposing cause of the paroxysm with the causal agency of the neurosis is prevalent among

§6. Disease of aorta.

§6. Disease of
aorta.

observers. The two causes differ from one another fundamentally ; for whereas one cause alone, namely, the neurosis, is the sole efficient agency in determining the paroxysm ; one of many efficient agencies in posse, is instrumental in causing the neurosis. For instance, the neurosis demonstrated as existing in the angina pectoris, results from irritative causes, affecting dendrites of neurons. When dendritic processes traverse pressure zones of aneurisms, new growths, pericardial or pleural adhesions, or inflammatory hyperplasias, they are subject to pressure, traction, or other such processes, and they and their cell bodies, seated at centres of the cord, become hyper-irritable, in other words, a neurosis is established. Neurosis once established at a segment of the cord involves centres of other near and even distant segments.

That a causal relationship exists between certain forms of aortic disease and the angina pectoris, has been fully established through clinical and pathological evidences introduced by Sir Clifford Allbutt, in his recent comprehensive work on this complaint. But is aortic disease the sole factor in the production of the angina pectoris habit? I think not. Many cases of angina pectoris are reported by careful observers, in which, at the autopsy, even after the most patient scrutiny, no traces of aortic disease were discovered ; yet aortic disease is the most frequent of arterial diseases. In my own practice I have met with two such cases. In both instances autopsies were conducted by practised pathologists who examined the heart, its valves, and its vessels, including the aorta, with great care, and failed to find

any abnormal conditions whatsoever. Both subjects had suffered during life from well defined seizures of angina pectoris of severe type, provoked by walking or by going upstairs. Of the autopsy on the famous case of the "Unknown," performed by no less an authority than John Hunter, Heberden says:—

§6. Disease of aorta.

"The contents of the thorax were examined with peculiar attention, particularly the heart with its vessels and valves, and were all found to be in a natural condition except for some few specks of a beginning ossification upon the aorta and some adhesion of the lungs to the pleura on the left side. The left ventricle of the heart was strong and thick and as perfectly emptied of blood as if it had been washed."

Indeed in Vol. 2, Diseases of Arteries, p. 462, Sir Clifford writes:—

"I can no longer hold that the source of angina pectoris is exclusively aortic." In the context he admits that the paroxysm may result from traction upon sympathetic nerves through inflammation of pericardial investments. This conclusion is illustrated with a reference to Auscher's case, which, at the necropsy showed, that while the aorta was flexible, elastic and healthy, definite signs of old chronic pericarditis were present.

If the existence of a source, alternative to the aortic, be admitted, is there any valid reason why other alternate sources equally potent should be excluded from consideration; for instance, inflamed investments of lungs, stomach or common gall duct. Inflammatory hyperplasia or post inflammatory contraction occurring in any of these situations is alike a potential and an efficient agency of traction or pressure, from these causes aneurism cannot be excluded.

§6. Disease of
aorta.

The anginous habit may spring from any one of these sources or from one of several others which could be named. In other words, the sources of the anginous habit are multiple. Here I draw a distinction between the anginous habit and the anginous seizure. A person of the anginous habit possesses an idiosyncrasy which lays him open to seizures in the event of certain contingencies occurring ; for instance, when he walks, when he gives way to excitement, or when he overloads his stomach. The healthy person doing any of these things does not fall into convulsions. So any person habitually feeling anginous pain after entering upon these forms of activity is regarded by us as a subject of the angina pectoris. The fact that we do so regard him, is evidence of the existence of a chronic habit in anginous subjects.

Where is this habit lodged, in cardiac, gastric or tubal investments ; in the musculature of these structures where such exist ; or in the central nervous system ? I do not wait for answer. Every day clinical evidence reminds us that continued irritative processes occurring at peripheral endings of afferent nerves, produces irritation at central stations. It can then be inferred with reason that inflammation or other agencies of traction pressure or irritation occurring in cardiac, pleuritic or tubal investments, is attended by hyper-irritability at segmentary centres ; in fact that when these pathological conditions are present, segmentary neurosis is in being. Confirmation of this conclusion declares itself from the fact that inflammation of these structures or aneurism is attended by tenderness at points of outcrop of

intercostal nerves and rigidity of intercostal muscle leading to a sense of stiffness of thoracic walls. These are pathognomonic marks. I would suggest that segmentary neurosis is the pathological basis of the anginous habit and the predisposing cause of anginous seizures.

§6. Disease of aorta.

Is aortic, pericardial, pleuritic, gastric, or tubal disease the exciting cause of anginous seizures? Anginous seizures come and go in certain instances many times a day; in others diurnally; in yet others at frequent or infrequent intervals measured by days, weeks or months. Is this form of incidence characteristic of effects likely to be produced through any vagarie of inflammatory processes? To contrast the characteristics of incidence and cessation between inflammatory and anginous pain leads us to reject the hypothesis that the latter is a proximate symptom of an inflammatory process. The alternative suggestion that the proximate, that is to say the immediate underlying and predisposing, cause of the anginous seizure is segmentary neurosis and that the exciting cause is an impression impinging upon hyper-irritable centres, from spasm of visceral muscle, seems to offer the better interpretation of the symptomology.

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Section 7. *Significance of High Blood Pressure.*

§7. Significance of high blood pressure

HIGH blood pressure is frequently associated with the anginous pectoris, yet its presence is not essential to the production of the seizure. Several instances have come under my notice in which seizures have occurred during periods when blood pressure registered a low normal standard.

In more than one instance I have observed blood pressure to fall during seizures and to regain a normal standard after they had subsided; these occurrences are in accord with observations made by Sir Clifford Allbutt. During digestion, blood pressure, after a short initial rise, falls. Yet during digestion, generally after it has been in progress for some time, anginous seizures are readily excited, either by emotional disturbances or by muscular exercise. In certain instances related in Chapter I. Section 3, seizures occurred at meals and when the first mouthful of food was swallowed. That is before digestion began; nay, on occasion, they came on even at the sight of food, before a morsel had touched the lips.

If it be recognised that high blood pressure is a common symptom among members of the class of paroxysmal spasmodic disorders of the muscular tunic of the alimentary canal, and that the angina pectoris belongs to this class—see

Chapter XII.—frequency of high pressure in the disorder under consideration needs no other explanation. In the class of paroxysmal spasmodic disorders high blood pressure has no causal significance. It is an expression of sympathetic processes set in motion by segmentary neurosis, the predisposing cause of seizures. Such is its status in the syndrome of the angina pectoris; a strong type of the spasmodic class. Langley has demonstrated the effect of excitation of proximate strands of afferent sympathetic nerves distributed to the intestinal canal. We learn from this experiment that hyper-irritation of segmentary centres through this means raises blood pressure. In persons of anginous habit spinous centres have already been rendered hyper-irritable by irritative sympathetic impressions and hyper-irritability at these centres is the cause of high blood pressure as well as the predisposing cause of all other symptoms of the anginous syndrome.

In Bright's disease blood pressure may register a high standard and remain elevated for years without causing anginous seizures. In examples under my own notice, blood pressures ranging between 200 and 300 mm. hydrarg, have remained in evidence for ten or fifteen years without provoking a single anginous seizure.

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Section 8. *Dyspnœa and Orthopnœa.*

§8. Dyspnœa
and
Orthopnœa.

DYSPNOEA and its associated phase orthopnœa have no regular place in the anginous syndrome, yet in certain instances they and angina are related, for both may spring from high intra-abdominal pressure. When the stomach is full and when the colon is distended, few among the most robust in health are found, who are able with comfort to mount stairs or hills, or who can rest their heads upon a low pillow, without laboured breathing. The stomach is the nexus associating dyspnœa with the angina pectoris.

There is a hidden factor less remote than the stomach, namely intra-thoracic minus pressure. Intra-thoracic minus pressure takes an essential part in the production of normal circulatory activities. Through its aspiratory influence, auricular walls suffer diastole and through this influence they and the great venous tributaries of the chest are filled with venous blood. In the absence of aspiratory potential energy blood accumulates in pulmonary vessels and dyspnœa results.

What is the connexion between high intra-abdominal pressure and low readings of intra-thoracic minus pressure? In the presence of high intra-abdominal pressure the aponeurosis of the diaphragm is raised; in equal measure the cavity of the thorax suffers constriction and a fall is registered in intra-thoracic minus pressure. This fall in minus pressure

determines arrest of diastolic expansion of auricles, §8. Dyspnœa and Orthopnœa.
stagnation of blood in pulmonary veins, and dyspnœa.

Why is dyspnœa more urgent during the supine pose of body than during the erect ? During the erect posture muscular walls of the abdominal chamber are hypertonic, crura of diaphragm are contracted and the mean working plane of the diaphragm is at a low level. As a result of a depressed diaphragm the thoracic cavity is enlarged and the standard of intra-thoracic minus pressure is raised. For this reason the dyspnœic subject breathes more freely, during the erect pose of body, than during any other.

Conversely, when the dyspnœic subject lies down, pillars of the diaphragm undergo relaxation ; diaphragm seeks a higher plane ; chest capacity is lowered ; intra-thoracic minus pressure falls ; auricular diastole languishes, and arterial blood lingers in pulmonary venus channels. Consequently breathing, which is laboured during the upright posture, becomes gasping in the supine.

Respiratory difficulties of the dyspnœic subject are further aggravated by enlargement of the right ventricle through increased resistence in pulmonary circulation. An enlarged heart reduces intra-thoracic minus pressure ; thus a vicious circle is established.

Section 9. *Summary of Reasons against the doctrine that Anginous Seizures result from a Myocardial Reflex.*

§9. Summary.

FOR more than one hundred years, writers of text books and teachers in schools have been wont to refer anginous seizures after a general sort of way to the heart, and this without adverse comment from outside, but whensoever they have attempted to locate the particular seat of the disease or to define with exactitude the nature of its operations, the explanation advanced has sooner or later been turned down.

2. Even protagonists of the cardiac theory admit, that during the throes of the paroxysm, the pulse may continue to pursue undisturbed the even tenor of its way.—See Section 3.

3. That exhaustion of the contractile function of the heart or loss of reserve energy is the causal factor, is a proposition not confirmed by clinical observation. Anginous subjects, immediately after subsidence of seizures, are known not infrequently to walk many miles without suffering from further thoracic discomfort.—See Section 4.

4. Coronary disease is not the causal agency. Statistical evidence demonstrates that coronary disease is not more prevalent in anginous subjects than in other subjects of atheromatous habit, in which seizures have never occurred.—See Section 5.

5. Theories of cardiac spasm, coronary occlusion and claudication are hopelessly discredited. It is open to demonstration that during anginous seizures the activities of the five functions of Gaskell remain unimpaired.—See Section 3.

6. That aortic disease, aneurism, lesions of investments of the heart, pleuritic and pericardial effusions and adhesions are remote or sub causes of the anginous habit is a proposition abundantly proved by clinical experience; but that any of these things is capable of exercising the office of predisposing or exciting cause is a proposition lacking proof.—See Chapters VIII. and IX. §9. Summary.

7. Afferent nerves of the myocardium are directed to medullary centres, consequently muscle of the heart is not in touch with pain tracks, and impressions emanating from it are incapable of causing anginous pain.

8. In the anginous subject signs of vagal inhibition are not of infrequent occurrence and death, when it happens, results not from initial cardiac failure, but from a stroke directed from a vagal and hence from an extra-cardiac source.

9. The cardiac reflex determining the anginous seizure is said to be excited by high blood pressure. On this subject Sir Clifford Allbutt's remarks are interesting:—"The imminence of angina during digestion, whatever the explanation, is well known. As regards arterial pressures, these during digestion fluctuate a good deal. Usually there is an initial rise for a few minutes, then a fall on the whole for about an hour, then a rise of some duration. Excitement of angina on a full stomach can scarcely be due to blood pressure."—Diseases of Arteries, Vol. 2, p. 343.—See also Section 7 of this chapter.

10. *Ædema* when present results from lack of tonus in extra arterial involuntary muscle of tissues, or from a surcharged colon, and cannot be regarded as evidence of a cardiac source.

11. It is asserted that the angina pectoris is a protective cardiac reflex phenomenon, but the only protective cardiac reflex process known to science is conducted through the depressor mechanism, and results in vaso-dilation of systemic

§9. Summary. arteries and arterioles; a process which induces neither discomfortable sensation nor pain.

12. Dyspnœa and orthopnœa found occasionally occurring in anginous subjects, are not conditions attributable to angina.

13 Tachycardia, brodycardia and arrhythmias, prevalent in anginous subjects, are expressions from the central nervous system.

14. Since the hypothesis of spasm of the myocardium as the cause of the anginous seizure has been found wholly untenable by those who previously had supported the doctrine of a cardiac reflex, it has given place to the view that the paroxysm is a result of functional or organic weakness of the myocardium, and that pain attending the attack is really a cry from a distressed heart muscle. But if this be so, we would ask with Sir Thomas Oliver, "How in anginous subjects do we explain the absence of shortness of breath?" In cardiac disability, dyspnœa is one of the most frequent of symptoms. Yet all authorities agree that dyspnœa has no place in the anginous syndrome, and when perchance found in an anginous subject the circumstance is co-incidental.

Chapter VII.

The Predisposing Cause.

- Section 1. The Anginous Habit.
- Section 2. Organic Lesions traceable to a Chronic Neurosis.
- Section 3. Genesis of Segmentary Neurosis through Functional Agencies.
- Section 4. Genesis of Segmentary Neurosis through Organic Disease.
- Section 5. Types of Neurosis.
- Section 6. Schema of Reasons in favour of the Hypothesis that Segmentary Neurosis is the Predisposing Cause of Anginous seizures.

Section 1. *The Anginous Habit.*

IN accordance with our conception of the nature of the §1. The anginous habit.
 angina pectoris, persons prone to seizures are possessed
 of the anginous habit ; lacking this habit, individuals
 suffering from visceral disorder of whatsoever kind it be, are
 not subject to seizures. The anginous habit is lodged in
 segments of the cord and in glosso-vagus accessory nuclei of
 the medulla. Proofs of its existence are furnished by a con-
 sideration of certain features of the symptomology.

§1. The
anginous
habit.

Symptoms described in previous chapters consist of five groups : (1) The central nervous group comprises referred pain felt in the distributory areas of the brachial plexus and the second, ninth and intermediate intercostal nerves, and algæsia affecting scattered patches of the integuments and deeper structures of the thoracic wall and adjacent parts ; (2) the secretory group comprises a voluminous flow of watery saliva and increased secretion of lachrymal glands with probably also increased urinary secretion ; (3) the parietal muscular group comprises contractions of facial, intercostal and abdominal muscle, the latter contractions producing a sensation of pressure over the thoracic wall described by some as fixation or tightness of the chest walls ; (4) the visceral muscular group comprises nausea, retchings, and eructations resulting from contractions of the gastro-cæophageal sheet and diaphragm ; and (5) the cardio-arterial muscular group comprises vaso-constrictions, elevation of blood pressure, abnormal deviations in pulse-rate and disturbances of rhythm and sometimes total inhibition of cardiac function.

The seizure consists of the associated manifestations of these several groups of symptoms. Parts involved in groups 2 to 5 inclusive are not in functional communication with one another except through the central nervous system. Hence the central nervous system furnishes the link that connects in a unity of expression the several activities that produce the seizure. The central nervous system must therefore be regarded as the seat of the predisposing cause, otherwise activities producing the seizure would fail to combine in unitary expression. For if the heart be the seat of the predisposing cause, how are symptoms witnessed during seizures to be accounted for ? If segmentary centres be healthy can impressions from the myocardium cause cramp in recti abdominis muscles or agonising pain in distributory regions of intercostal nerves ? Can impressions

generated in the myocardium cause nausea, overflow of saliva, §1. The
 retching, eructations of gas, and vomiting? Through what ^{anginous} habit.
 mechanism can impressions emanating from the myocardium
 cause vaso-constriction in systemic arterioles and an eleva-
 tion of blood pressure? Without an appeal to a disordered
 central nervous system can any disease of the heart cause
 instant death? Even in complete heart-block the ventricle,
 if robust, still bears the burden of rhythm.

It may be replied that disturbance of myocardial function
 causes hyper-irritability at segmentary centres of the thoracic
 cord, and as a result of this morbid condition, symptoms
 indicated above appear. But apart from the fact that den-
 dritic connexion between the myocardium proper and segments
 of the thoracic cord is not open to proof, this statement
 merely affirms that the predisposing cause of the seizure
 really lies in the central nervous system, and that the remote
 cause of it is to be found in the myocardium. The
 hypothesis that the myocardium is the seat of the predispos-
 ing cause is therefore an absurdity. The same method of
 argument is applicable to all other alternative propositions.
 A confirmatory symptom is present during seizures and at
 intervals between them—viz., patches of algesia are found in
 the distribution of intercostal and spinal accessory nerves.
 Strands of the brachial plexuses in the posterior cervical
 triangle and branches of the plexuses in the arms are tender
 upon pressure. This symptom appears in regions where pain
 is never felt and at seasons when the patient is at rest and
 when seizures are in abeyance. In a certain case examina-
 tions have been made by me on frequent occasions during an
 illness of five years' duration, and in no instance has this
 symptom been entirely absent. But algesia shifts its ground
 from day to day—patches appear in a zonal area, remain in
 evidence for a few hours, disappear and reappear. Charts
 showing the distribution of patches of algesia are never

§1. The
anginous
habit.

found alike upon two days in succession. Precisely the same characteristics are noticed even at intervals when no seizures are occurring. It is evident that it is not the seizure which makes the patch, but that neurosis of segmentary centres determines both patch and seizure. Hence we are in a position to infer that a state of neurosis at segmentary centres is the predisposing cause of seizures, and that vagal inhibition is the cause of death.*

Dr. Lea, of Manchester, accepts tentatively the view that the basis of the anginous habit and the predisposing cause of seizures is segmentary neurosis and he emphasises the fact that seats of tenderness are found at the points of outcrop of intercostal nerves. He writes :—

Mr. Walter Verdon's letter in *The Lancet* of April 3rd bears out in many ways one's own personal observations in relation more especially to intercostal pain and heart disease. His contention, as I read it, is that segmental neurosis of that area of the cord which more immediately subserves the regions in the neighbourhood of the heart itself predisposes to anginal attacks, and, similarly, neurosis in other regions may favour spasmodic alimentary disorders. Such a neurosis may be secondary, I take it, to cardiac trouble, but not necessarily so. In a case I had recently under observation the relation of the pain or algesia to the frequent true anginal attacks from which she suffered could with difficulty be explained by any means other than some such segmental neurosis. This patient, who had well-marked aortic incompetence, had from day to day definite areas of deep and superficial intercostal tenderness, varying in site, as Mr. Verdon observes, from day to day, though at times certain intercostal areas, particularly the fourth, would show algesia at exactly the tender spots

* Stomach v. Heart. *Lancet*, April 3rd, 1915.

peculiar to such nerves—namely, near the vertebra in the axillary line, and near the sternum respectively. Very occasionally she would be free from such areas. In one such phase this patient, in my presence, had a definite anginal attack relieved after a few minutes by amyl nitrite. Afterwards there was not the slightest tenderness to be made out, contrary to what one ought to expect. The suggestion in such a case was that there was a segmental neurosis or possibly a definite radiculitis—the Wassermann was positive—and that this in the main predisposed her to attacks, which were exceptionally numerous. No stomach symptoms were ever present in this case. She died suddenly a few weeks ago.

Sir James Mackenzie and other writers of importance on the subject, while acknowledging the presence of a central neurosis during seizures, regard it as the product of loss of reserve of myocardial contractile energy and as the cause immediately underlying intercostal tenderness and intercostal and brachial pain. As far as it relates to pain and tenderness this admission in reality concedes the principal that, segmentary neurosis is indeed the predisposing cause of seizures. This principle being established the further admission follows as a necessary consequence, namely, that since as we all know, segmentary neurosis can be induced independently of morbidity at the myocardium, this organ is not necessarily the sole cause of the predisposition, nor yet alone can it be regarded as the sole exciting agency of the seizure.

The most significant signs of segmentary neurosis are tender spots appearing in distributary areas and at terminals of intercostal nerves. Branches of these nerves pierce deep

§1. The
anginous
habit.

§1. The
anginous
habit.

structures at well defined points, and end in dermal tissues. At these points of outcrop into sub-integumental space, tender spots appear, remain in evidence for a time, disappear and reappear. According to many repeated observations, charts recording location of tender spots at length show five vertical series of marks, namely, at margin of sternum, at costo-chondral articulations, at anterior axillary line, at posterior border of scapulæ and at spinous processes of vertebræ. Among records figured from cases in which algæsic symptoms are prominent, bilateral serial columns extending from the second intercostal space to epigastric and hypo-chondriac regions are noticed. In other examples tender spots are fewer in number, and again in a third set, they are sparsely represented, or absent altogether. Significance of these charted records arises from the fact that neurons which are tender at their distributary terminals are hyper-irritable in their entirety, consequently in cases spoken of, it must be inferred that bodies of neurons seated at segmentary centres are hyper-irritable; in other words a state of segmentary neurosis is in being.

Rigidity of muscles or groups of muscles indicates that during states of segmentary neurosis, axonic as well as dendritic, fields of distribution are affected.

As a result of segmentary neurosis, a prominent group of symptoms is witnessed in the angina pectoris. Thoracic walls are tender on pressure and on movement. They are fixed through spasm of intercostal muscles, and fail to respond to respiratory efforts. The patient describes them

as feeling wooden, and complains of tightness at the chest. Through tautness of thoracic walls and rigidity of recti-abdominis muscle, cardiac sounds and impulses are exaggerated and widely distributed. They extend upwards to the neck, downwards to the umbilical region, and bilaterally to the arm pits. Subjective sensations of throbbing attract the attention of the patient to activities of the heart, and consequently subjects of angina pectoris and observers alike, are readily led to believe, that this organ is the cause of the seizure.

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Section 2. *Organic Lesions traceable to a Chronic Neurosis.*

SEGMENTARY neurosis is found in existence before, during and after anginous seizures, and not infrequently it can be detected when seizures have been in abeyance for weeks or even for months. These facts strengthen the view that in angina pectoris, segmentary neurosis is chronic. This conclusion is confirmed by the appearance in anginous subjects of degenerative and other abnormal changes in tissue elements. Although exceptions to the rule are as frequent as examples, yet sufficient evidence exists to show that anginous disorder is associated with

§2. Organic lesions.

§2. Organic lesions.

organic disease of the myocardium, the joints, the skin and the mammæ.

The anginous habit may be attended by adenoid lumps in one or both breasts. In one case I noticed that neither the breast itself nor the lump was tender, but beneath the upper and outer border of the gland tender spots were present at points of outcrop of intercostal nerves.

In an anginous subject recently under observation, much tenderness was elicited when pressure was exerted over strands of the right brachial plexus and over ulna and median nerves on the same side. Joints of fingers were tender and swollen; a symptom coming soon after the appearance of the first seizure, which was followed by many others of a severe sort. During seizures or immediately after them, gas was expelled from the chest and loud borborygmal sounds were heard. At the time of examination the tympanitic area of the stomach reached above the sixth rib. The patient, however, declared that her digestion was healthy and that she never had suffered from gastric derangement. Her appetite was always good. After a prolonged course of dietetic discipline and regular administrations of glycerine of pepsin and pancreatin, this patient wrote saying that seizures had ceased and joints were no longer tender or swollen.

Sir Clifford Allbutt has recorded several cases in which lesions of the skin have been noticed and attributed to this complaint.

A few cases are on record of outbreaks of herpes on the painful arm. Burns says that on this account Mr. Hunter's left arm could not bear to be touched. Two physicians describe cases in which lichen planus appeared on the inner aspect of the left arm. In two of my own cases, not syphilitic, testes were atrophic. In one case after a severe

attack in which the left little finger was painful, a deep ^{§2. Organic lesions.} sulcus appeared in the nail. In another a persistent scaly copper coloured patch could be mapped out over left ulnar distributary region. Gibson gives an account of atrophy of the arm occurring in association with the anginous habit.

Dr. G. A. Gibson in his Morison Lectures, 1903, said:—
“Occasional trophic effects result in consequence of the nervous disturbance. The skin is sometimes seen to be thin and wasted, and in certain instances, two of the most striking of which have been narrated by Eichorst and myself, wasting and weakness of the muscles corresponding to the distribution of the pain were observed.”

Localised pleuritic friction was noticed in a person of anginous habit on two occasions. After one of a series of seizures, a frictional area was found below third and fourth costo-chondriod articulations on the right thorax. The rub was unattended by pain, but pressure upon surface integuments from the chest piece of the stethoscope evoked complaints of tenderness. The third day after the seizure, pleuritic friction sounds could no longer be detected. At a later seizure, some three months afterwards, the same phenomenon was noticed, but the pleuritic patch was then located at the fourth inter-space in the axillary line on the left side of the chest wall, and it, like the other, was found lying beneath a tender spot in the skin.

Adenoid lumps in mammary glands, swollen joints, skin affections and wasted muscle, indicate chronicity of the segmentary neurosis, and certain forms of myocardial decay of slow growth can reasonably be attributed to atrophic changes, resulting from the same cause.

Section 3. *Genesis of Segmentary Neurosis through Functional Agencies.*

§3. Genesis of segmentary neurosis.

DURING segmentary neurosis centres of protective reflex function are involved. Expulsion of contents of visceral cavities and tubes are ends of purposeful activities practised through protective reflex function. Importance attached by instinct to possession of these functions is emphasised by the fact that every living thing provided with a visceral cavity is endowed also with the faculty of emptying it. This being so, necessity for the perpetuation of protective reflex function is a chief factor in determining the course of evolutionary processes. This subject is treated at length in Appendix 1.

Protective reflex mechanism consists of a series of neuronics arcs seated in respective zones from oral orifice to anal. In visceral and parietal layers of muscle, limbs of the arc ramify. Strands of great splanchnic nerves and sympathetic plexuses constitute one limb; cervical and intercostal spinal nerves the other. The arc is centred in segments of the cord. Protective reflex function is conducted through muscle sense impressions. Hypertonus occurring in the visceral layer determines hypertonus in parietal groups and converse activities play their part also.

When intra-visceral pressure rises rapidly, visceral

muscle enters upon a hypertonic phase and muscle sense impressions are evoked. Reflex activities are now set in motion and parietal muscle responds to the call. Co-ordinated action of internal and external layers of contractile tissue result in unloading the surcharged tube or cavity; such is the mechanism and such the method of healthy physiological protective reflex function.

§3. Genesis of
segmentary
neurosis.

When morbidity enters the field, all this suffers change. The faculty of co-ordination is suppressed, muscle falls into spasm or grows rigid, and spots of tenderness appear.

During obstructed labour the transition from healthy reflex processes to unhealthy can be followed under our eyes. Labour begins with well-timed and perfectly co-ordinated activities. Uterine muscle grows increasingly tonic, and when a certain degree of hypertonicity is reached, parietal muscle entering the field of action, gives powerful assistance in securing efficient expulsatory effort. At pain after pain similar well-timed help is rendered. So far all processes are conducted after a purposeful manner. Now comes the change. Obstruction being obdurate, expulsatory efforts at first increased, begin to manifest irregularities and co-ordination loses precision. Uterine muscle may be active, while abdominal muscle lies idle, and converse conditions as often are in evidence. From time to time, parietal muscles fall into spasm. After a fitful fashion cramp attacks gastroc-nemii recti-femoris and recti-abdominis. At times spasm appears in far distant regions, as wrist and hand. Diaphragmatic action produces hiccough. The contractile stomach refuses to entertain food and throws off large volumes of gas. Tender spots are plentifully scattered over buttock and thigh. In a case seen by me about two hours after obstructive signs had begun to appear, mammae, full previously, were shrunk,

and tender spots were found in fourth, fifth and sixth intercostal spaces. Extra systolic arrhythmia was present, breaking, at frequent intervals, the regular tenour of the pulse.

Much the same order of events happens in cases of intestinal obstruction.

Pain reaches high pitches of intensity. It belongs to diffused and deflected sympathetic types. When obstruction is overcome, and the cause of it is removed, symptoms quickly subside, and at length vanish. These are examples which might, not inappropriately, be called uterine and intestinal angina, resulting through long drawn out hypertonus of visceral layers of muscle and initiation of segmentary neurosis.

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Section 4. *Genesis of Segmentary Neurosis through Organic Disease.*

§4. Segmentary neurosis arising from organic disease.

SEGMENTARY neurosis of a highly intensive type is bred when dendrites of segmentary neurons are subjected to pressure, tension, irritation, and to other forms of stress, through the presence of organic disease, in investments or mesenteries of organs, or in subserosæ of pericardial pleural or peritoneal sacs. In subserosæ of these sacs dense reticular plexuses ramify, and these plexuses are in anatomical and functional connexion with centres of the cord at every segment. Moreover, sympathetic subserosal

plexuses are reinforced by strands of vagal nerves, and hence impressions impinging upon them, are conducted to both segmentary and medullary centres.

§4. Segmentary neurosis arising from organic disease.

So aortic aneurism, new growths, inflammatory hyperplasias, contracting pleuritic or pericardial adhesions, and syphilitic lesions, are pregnant sources of segmentary neurosis, and hence of the anginous habit. They induce dendronitis at terminals of neurons affected by them, and secondly they induce hyper-irritability at segmentary centres and tender spots and patches in fields of zonal distribution of spinal nerves.

Sir Clifford Allbutt, in Vol. 2, Diseases of Arteries, introduces many examples of angina pectoris associated with aortic disease.

A man in the course of a violent effort broke down one aortic cusp and also forced out a pouch above it in the supra sigmoid portion of the aorta. The first and the most abiding symptoms were attacks of angina pectoris, the pain radiating as usual down the left arm. These attacks beset the patient till his death six months afterwards. This case is quoted from Heller's papers.

Dr. Gibson says the initiatory stage of aneurism of thoracic aorta is attended with anginal symptoms in a large proportion of cases, with this statement Sir Clifford Allbutt agrees. Sir William Osler says severe attacks may occur in early periods of aortic aneurism. They were noted in the histories of twenty-two out of one hundred and thirty-two cases. Gairdner in essays on aneurism quoted cases of referred pain, and related them to districts of Mackenzie and Head. In not a few instances in which diagnosis from other observations is well established, aneurism of the arch of the

§4. Segmen-
tary neurosis
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organic
disease.

aorta leads to symptoms closely resembling typical angina pectoris with pain and numbness of the left arm, extending sharply from the chest into the neck, face, shoulders, and down one or both arms. Quinke says, Thoracic aneurism may assume all the well-marked phenomena of angina pectoris.

Trousseau describes two severe cases of angina pectoris in initial stages of thoracic aneurism. Morgangi relates the case of the wife of a painter, aged forty, with violent pains in the chest and arms. At the autopsy, a narrow ulceration was found a little above the semilunar valve. Lancisi, in an unmistakable case of angina, noted an aneurism of the aorta. Desportees also noted a case of similar character. Gairdner says small aneurisms impinging upon the heart are especially productive of angina. Also in another place he says, even small aneurisms, if arising very near the heart and especially such as project into the pericardium or compress, in any degree, the base of the heart are much more apt, than others, to give rise to anginous symptoms. Sir William Osler says:—"There may be paroxysms of pains often simulating angina in cases of small aneurisms at the root of the aorta. In fact there is a special group of cases in which angina pectoris is the initial symptom of aneurism of the aorta." One of Mackenzie's cases was that of a male, aged 40. Tightness across the chest and pain down the inside of both arms, especially on exertion. Death sudden. P.M.: Small aneurism of aorta immediately above the aortic valve. Both coronary arteries were healthy. Some fatty degeneration of the myocardium.

In Vol. 3 of the Medical Transactions of the Royal College of Physicians, Haygarth, of Chester, reported a case of angina pectoris which at the autopsy showed mediastinal suppurative inflammation. Steill records four cases. The third of his series was one of typical angina with pericardial friction ending in recovery. Of the fourth, he says the

diagnosis of angina was clearly established. Pericarditis was present. Sallavardin says that the pain of certain cases of pericarditis put on the character of angina. Sansom stated that in rare cases, pain in pericarditis is paroxysmal and has the characteristics of angina pectoris. Dr. Byron Bramwell has described a case of angina associated with pericarditis. Patient was attacked with angina pectoris, but for a day or two nothing abnormal was found about the heart, then for a day or two a distinct pericardial rub became audible. The pericarditis lasted for a fortnight, after which time the patient made a rapid recovery. Dr. Morison says occasionally a case of pericarditis presents itself with the characteristic distributive and special features of a true anginous seizure. Wrintrand speaks of a severe pain behind the sternum and through to the back, radiating up to the neck and sideways to the arms in cases of pericarditis. He adds the remark that in its fuller manifestations this pain corresponds to typical angina pectoris; so that presumably the slighter but similar manifestations are of the same nature. Auscher mentions a case of angina pectoris associated with posterior basic pericarditis and inflamed aortic investments. In this case the heart and coronary arteries were sound. Pawinski records eight cases of his own which were marked by anginal pain of intense degree. Sir Clifford Allbutt in describing the above series of cases, refers to a private letter from Sir James Mackenzie, wherein his attention is invited to rare cases in which the pain of pericarditis has the same distribution as in angina pectoris.

§4. Segmentary neurosis arising from organic disease.

A case on my own list, John B., illustrates pleural origin of neurosis. Thorax was tapped during an attack of pleurisy, and fluid in quantity was drawn from the left pleura, since this operation the heart had given trouble. Before the attack he had been a strong man suffering from no thoracic symptom. On going out for the first time after

§4. Segmentary neurosis arising from organic disease.

the operation, and when walking he was seized with pain which began in the epigastrium, and spread upwards to the chest, affecting mid-sternal regions and the root of the neck. Pain was accompanied by a sense of strangulation. He thought that this attack would kill him. The sense of approaching death weighed upon him during the course of the seizure, which lasted fifteen minutes. This was the prelude to many other attacks. The patient rapidly improved under twenty grain doses of potassium iodide; and completely recovered after three months treatment with the same drug in reduced doses.

In another of my cases, namely in that of a married lady, Mrs. D., who suffered from anginous attacks for over ten years, and ultimately died in a seizure, the first attack occurred during convalescence from pleurisy. Dry pleuritic friction sounds were audible during the entire period of prevalence of seizures. No cardiac disease was detected. From time to time I examined the chest and always found tender spots present. Points of outcrop of intercostal nerves on both sides of the chest were tender; third, fourth and fifth left intercostal terminals being chiefly affected.

At the autopsy of Heberden's case of the "Unknown," left-sided pleuritic adhesions are described as present.

In a case of angina pectoris, quoted by Ewart, inflammatory pleural adhesions of a chronic tuberculous nature were present in the anterior mediastinum. Sir Clifford Allbutt describes numerous cases of perforating ulceration of the aorta. Primary cardiac angina is described by Sir Clifford, but it is significant that the three classes named by him are chiefly related to the investments of the heart, or its fibrous structures, not to the myocardium itself. The classes are:—(a) Those associated with mitral disease, and especially with mitral stenosis. (b) Those associated with thrombosis,

aneurism or rupture of the ventricle, often with a focal pericarditis. (c) Those associated with pericarditis.

§4. Segmentary neurosis arising from organic disease.

Mitral stenosis and pericarditis are efficient agencies of segmentary neurosis, since in these diseases dendrites of neurosis ramifying in subserosæ are subjected to irritative influences, these diseases may constitute themselves remote causes of anginous seizures.

Cases referred to in this chapter functional and organic are examples of potential and direct agencies of causation of segmentary neurosis, but they are remote agencies in causation of the paroxysm. Ulcerations of aorta, syphilitic lesions and pleurisy, can well be classed as potential agencies in the causation of segmentary neurosis, since each and all are factors which do give rise to lesion of those dense vago-sympathetic plexuses which ramify in the tissues of the subserosæ. They are agencies of traction, pressure inflammation, and irritation, of strands of vagus and sympathetic dendrites. Patches of tenderness are found in conjunction with these agencies and this symptom is a sure mark of segmentary neurosis.

Since through the great splanchnic nerve segments of the cord are in axonic connexion with strands of the muscular tunic of the stomach. Segmentary neurosis induced through organic disease associated with investments of the heart and aorta, or with subserosæ of pericardium and pleura, is an efficient agency in the causation of hypertonus of gastric walls, elevation of intra-gastric pressure and spasm of gastro-oesophageal musculature. The part played by high intra-

gastric pressure in the excitation of seizures is discussed in the next chapter.

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Section 5. *Types of Angina Pectoris.*

§5. Types of
angina
pectoris.

THERE are two types of angina pectoris: the one functional, the other organic. In the first type segmentary neurosis results from functional disorder of viscera; in the second it is produced through inflammation or organic disease. In a large proportion of anginous subjects the neurosis springs from functional causes.

Forbes, in *Cyclopedia of Medicine*, 1832, wrote that "no organic disease exists in fifty per cent. of anginous cases and in the rest it is associated with all manner of organic, aortic and cardiac lesions;" and Sir R. D. Powell, in *Lancet*, June 29th, 1901, gives his settled opinion that "in a large proportion of cases angina is an entirely functional disorder."

Although all anginous seizures resemble one another in essential features, differences are noticed in degrees of spasm and pain. Attacks of a severe type are classified in text books as examples of the angina pectoris major; attacks of lesser severity, as instances of the angina pectoris minor. From clinical experience we gather that intermediate forms are numerous. No one can say where the class of angina

pectoris major begins nor where the category of angina pectoris minor ends. Occasionally I have noticed persons walking in crowded thoroughfares to stop, and, after heaving up gas, to continue walking again. Such persons explain that the halt was due to discomfort and overpowering sensations at the chest, which vanished suddenly with the escape of gas. These are examples of angina pectoris minor.

§5. Types of
angina
pectoris.

Again, I have observed persons coiled or writhing in an extremity of pain, with faces pinched, pale, grey or livid, bathed in sweat and convulsed with terror; mouths welling with frothy slime; necks disfigured by engorged veins pulsating like swollen arteries; chests shaken by a thumping heart and fingers clutched upon indented palms. These are examples of the angina major. With these illustrations under our eyes, it is difficult to accept the hyperthesis that they represent nothing more than different forms of one complaint. Yet the hypothesis is true. I have seen the same persons, at one time suffering from the one form of attack, at another time from the other. How can these freaks of symptomatology be accounted for? The argument running through the pages of this work enunciates the doctrine that symptoms of minor and major forms of the angina pectoris alike result from segmentary neurosis, and that diversity in the form of the seizure is dependent upon difference in degree of intensity of the neurosis. All that can usefully be said in furtherance of correct diagnosis is this:—Anginous seizures of the minor type usually indicate a neurosis generated through functional disorder; whereas those of the major type, particularly when

attacks of this form are persistent, point to an intensive neurosis springing from organic disease.

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Section 6. *Schema of Reasons in Favour of the Hypothesis that the Predisposing Cause of Anginous Seizures and the basis of the Anginous Habit is Segmentary Neurosis.*

§6. Summary

IN all forms of anginous seizures, signs of segmentary neurosis are apparent.

2. Attacks are paroxysmal; the complaint is found chiefly among persons engaged in mental labour and subject to mental strain; seizures begin unexpectedly and end suddenly; one of the chief differential features of the paroxysm is nervous trepidation; the complaint is not infrequently found among neurasthenic and hysterical subjects; death results from vagal inhibition.

3. Pain during seizures rises to high pitches of intensity, equalled in character and severity only in tetanus and in other disorders of the kind belonging to the spasmodic, class, deriving the basis of their predisposition and habit from segmentary neurosis.

4. The cast of features produced by angina pectoris typified in the risus sardonicus is common enough in all forms of spasmodic disorders associated with the muscular tunic of the alimentary canal, which alike owe their origin to segmentary neurosis.

5. Tenderness at the terminals of intercostal nerves

found in anginous subjects is a pathognomonic mark of §6. Summary segmentary neurosis.

6. Rigidity of intercostal and recti-abdominis muscle, a symptom of the anginous syndrome is also a pathognomonic sign of this neurosis.

7. In anginous subjects loss of epicritic faculty at the finger tips and cold and anasæthic patches of integument at the loins and outer aspects of the thighs are symptomatic of this neurosis.

8. Adenoid lumps in the mammæ, hypertrophic thickening at joints of the arms and hands, chronic dermatitis and wasting of muscle, occasionally found in anginous subjects are marks of the chronicity of the segmentary neurosis.

9. Symptoms of the anginous syndrome envisage the category of functions lodged at segmentary centres of the cord, and although their activities are disorderly and incoordinate during seizures, their nature is readily recognised. Consequently their contemporaneous expression is rationally accounted for upon the hypothesis of segmentary neurosis.

10. Persons affected by anginous seizures are subjects of the anginous habit. Habits are not resident in muscle nor in any other tissues except in central nervous. It is concluded that the anginous habit finds its pathological basis in segmentary neurosis.

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Chapter VIII.

The Exciting Cause.

- Section 1. The Gastro-œsophageal Track is the Seat of the Exciting cause.
- Section 2. Anatomical Basis of Muscle Sense Impressions occurring during Anginous Seizures.
- Section 3. Dangers to the Heart arising from High Intra-gastric pressure.
- Section 4. Gas as the Medium of Resistance.
- Section 5. Identification of the Seat of the Exciting Cause.
- Section 6. Schema of Reasons in favour of the Hypothesis, that the seat of the Exciting Cause is located in the Gastro-œsophageal Track.

Section 1. *The Gastro-œsophageal Track is the Seat of the Exciting Cause.*

§1. Seat of the exciting cause.

CONSIDERATIONS in which we are now engaged involve an examination of factors capable of setting the neurosis, designated the predisposing cause, in motion, and thus constituting themselves exciting causes of the seizure.

Two sheets of visceral muscle traverse segmental zones in which anginous pain is felt, and certain observers think

that pain arises from the myocardio-arterial sheet, and certain refer it to the gastro-cæophageal. The reason why muscular tissue, rather than any other visceral structure is marked out for consideration, is because referred visceral pain, such as that felt in the angina pectoris, is a muscle sense impression, hence it is argued that one or other of these sheets is involved. Arguments in favour of this view are advanced in chapter 2, section 1, also in section 5 of this chapter.

§1. Seat of the exciting cause.

Certain difficulties lie in the way of making a differential selection as between these sheets of muscle. Each sheet, while traversing affected zones, inclines in its course to the left side, rather than to the right. Both sheets enter upon abnormal activities during the seizure, the one displaying arrhythmic phenomena, the other engaging itself in spasmodic contractions, resulting in eructation of flatus, retching and emesis.

The question requiring answer is by which sheet are generated muscle sense impressions effective in setting the segmentary neurosis into motion and thereby instrumental in the determination of intercostal pain and spasm. The question is answered by an appeal to text-books on physiology. The gastro-cæophageal sheet of muscle is in dendritic connection with segments of the cord. Segments of the cord are in axonic connection with the cardio-arterial sheet, consequently impressions generated in the gastro-cæophageal sheet following their accustomed path reach their primary destination in centres of the cervical and thoracic cord, and are further propagated to the myocardium. The course is thus open for gastro-oesophageal muscle sense impressions to impinge upon hyper-irritative segmentary centres and to constitute themselves the exciting cause of seizures.

Is it within the power of the cardio-arterial sheet of muscle to play the same role? Assuredly not. All neuronie connections between the myocardium proper and segmentary

§1. Seat of the exciting cause.

centres of the cord are axonic, and axonic processes convey impressions from centre to periphery but not in a converse direction. Consequently impressions generated in the myocardium are not provided with a path over which they may reach segmentary centres. Disturbances of the myocardium can produce neither thoracic pain nor gastric disorder *via* the cord. Unless our text-books on physiology be mistaken and our latest views on referred pain be erroneous, sternal and retro-costal pain cannot rightly be referred to myocardial derangement. We have no other course open to us than to look upon myocardial disorders occurring in the angina pectoris as symptomatic.

Since the foregoing words appeared in an article contributed by me to the National Medical Journal, August, 1915, Sir Clifford Allbutt has given ample confirmation of views therein expressed, namely, that the myocardium does not possess a neuronic mechanism capable of causing pain in thoracic regions.

"We have no histological evidence," writes Sir Clifford, "of any direct connexion of sensory nerves with the muscle of the heart or of the vessels. I would urge, then, that any pain caused by undue extension or contraction of the heart, must be assumed to arise from the tension exerted on the connective tissue investing these organs, and to be conveyed from the connective tissue by the nerves that end within it.—Diseases of Arteries, Vol. 2 p. 420.

We are confirmed in our view that cardiac disturbances occurring during anginous seizures are symptomatic expressions without causal significance, by the fact that cases are very numerous in which agonising pain is co-existent with even and undisturbed rhythm. In chapter 6, section 3,

quotations from the writings of authorities are given, which, I think, are convincing on this point. In the same chapter a series of observations on contemporaneous jugular and radial tracings during seizures is described. In a series of observations, in no single instance is any defect in the five functions of Gaskell detected.

It is no uncommon thing for persons after eating a large and indigestible meal to be seized with nausea, retching, eructation of gas, discomfortable sensations of pressure and pain at mid or upper sternal regions, and to manifest a halting pulse. Moreover, upon examination, many of them disclose high tympanitic resonance, extending upwards to a plane as high as the fifth rib. From them, symptoms instantly vanish after sour, frothy, lumpy matter has been expelled from the stomach. If the subject be without history, the diagnosis is gastric disorder, and without hesitation it is affirmed that pain, cardiac disturbance, and other expressions of the seizure, result from gastric reflex function.

But if the patient possess an anginous history, what shall be said? Many clinicians assert that a seizure identical in chief features to that described, results from a cardiac reflex; and that every symptom appertaining to it, even the retching, the eructation, and the vomiting, starts from this remote source.

It is argued by persons of this bent of mind that as gastric derangements are common in many forms of cardiac disease, so in angina pectoris they must be expected. That

§1. Seat of the exciting cause.

§1. Seat of
the exciting
cause.

cardiac and gastric disorder often appear together I agree, but from the conclusion, that the latter springs from the former, I differ. For whether the case be anginous or not, success which attends treatment of the stomach and failure which dogs cardiac remedial measures, indicates that stomach is the causal factor, and cardiac disorder a symptom only.

Muscle sense impressions which start seizures and are felt during their course, furnish conclusive evidence of the source of their genesis. Muscular tunics of stomach and œsophagus generate sensations recognised as nausea, desire to eructate flatus, fulness and globus. These sensations indicate that muscular tunics of œsophagus and stomach are engaged in hypertonus or spasm, no sensation of this kind can emanate from organs other than œsophagus and stomach, and when discomfortable sensations of this character are noticed merging into crushing and bursting pain, the source of this symptom needs no further explanation.

Moreover, intercostal pain in anginous seizures is located at higher, lower, mid planes of thoracic walls and sometimes pain is felt in the epigastrium. No other sheet of muscle but the gastro-œsophageal, traverses these zonal regions in their combined entirety, and consequently no other but the gastro-œsophageal tunic can give rise to this wide spread symptom. We shall now examine critically the field of musculature, suggested by these considerations, as the agent of anginous pain, and as the source of all other symptoms of the syndrome.

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Section 2. *Anatomical Basis of Muscle Sense Impressions.*

THE muscular tunic of the cavum pylori is the chief seat of muscle sense in the stomach. On a skiogram of the stomach in action this portion is represented as almost vertical and in direct continuity with the œsophagus, the fundus forming a pouch to the left and upper end. Figure 907, p. 1150, Cunningham's Anatomy, represents a quiescent stomach. Here it is noticed that the œsophageal opening in the diaphragm lies on the horizontal plane of the 10th thoracic vertebra and pylorus on that of the first lumbar. The vertical plane of the œsophagus being half an inch to the left of that of pylorus. Between these points the outline of the stomach forming the lesser curvature is deflected slightly to the left.

At a central point of this curvature, which corresponds with the situation of the cavum, is seen the stem of the cœliac artery, bearing upon its branches prolongations from the cœliac mixed plexus of sympathetic and vagal nerves to innervate the muscular tunic of the cavum. The abundance of supply of vessels and nerves to the cavum, indicates the importance of this region of the stomach as a functionating agency. Its importance is recognised also by the thickness of its muscular tunic, which is its sole organ of sense. Alone, this portion of the muscular tunic is in afferent connection with both pain and cardio-inhibitory tracks of the central nervous system.

Of the muscular tunic of the cavum, the longitudinal layer is the most interesting to us, because it is in direct

§2. Anatomical basis.

continuity with the longitudinal layer of the œsophagus, and, as later shown, it may become an exciting agency of cardiac inhibition.

The stratum longitudinal consists of longitudinal muscular fibres continuous with those of the œsophagus on the one hand, and with those of the duodenum on the other." Cunningham's Anatomy, fig. 926a. "They are most easily traced on the lesser curvature and they can be followed down from the right side of the œsophagus. Over the greater curvature, and on its two surfaces, they are present as an extremely thin and irregular sheet. Towards the pylorus these longitudinal fibres grow much thicker and also much tougher and more closely united, and they take part in the formation of the pyloric valve. A specially condensed band of these fibres can be made out on the front and back of the antrum pylori, the form of which is said to be due to their presence. The bands are known as the ligamenta pylori." Cunningham's Anatomy, p. 1174.

As in the stomach, so in the œsophagus, the longitudinal layer of the muscular tunic is of peculiar interest. At its upper end the longitudinal layer is attached to the cricoid cartilage; at its lower end, it is in continuity with the longitudinal tunic of the stomach. Strands of this layer are highly developed, being as stout, and in some portions, stouter than the circular section. Junction of longitudinal strands of the œsophagus with those of the stomach occurs at the seat of hour glass contraction, that is to say, at the *cavum*.

Certain vagrant strands, which are off-shoots from longitudinal muscle, form attachments to pleural and pericardial sacs. One of these strands, sufficiently constant to receive a distinctive name, the *m. pleuro-œsophageus*, is attached to

left pleura, half an inch above the diaphragmatic orifice. §2. Anatomical basis.
When followed downwards this strip is noticed to be in continuity with longitudinal strands of the *cavum pylori*. Vagrant strands of the *œsophageal tunic* are also attached like clingers of a creeping plant, to the pericardium, to the aorta, and to the right pleural sac. Relationship between *œsophagus* and *pleura* demands full description.

“Above the level of the arch of the aorta and of the *venæ azygos*, between which the *œsophagus* descends, the *pleuræ*, though not lying in immediate contact with the *œsophagus*, are separated from it only by a little connective tissue, and on the left side also, behind the *subclavian artery*, by the *thoracic duct*. Here in thin bodies, the left pleura is very close to the *œsophagus*, and the *thoracic duct* lying on the left side, may occasionally be seen through the pleural membrane. Below the arch of the *azygos vein*, the right pleura clothes the right side of the *œsophagus*, and very often a considerable portion of its posterior surface too, these forming a deep recess behind it, almost as low down as the opening in the diaphragm. On the left side, below the level of the aortic arch, the left pleura comes in contact with the gullet, only for a short distance just above the diaphragm.”
Cunningham's Anatomy, p. 1153.

Through experimental methods, sensory innervation of muscular tunics of *œsophagus* and stomach is not determined as readily as motor innervation, because in this case, stimulation gives no physical sign. But through a process of deduction, we are enabled to formulate a working rule. Muscular strands receive innervation from both groups of *autonomic nerves*. Strands receiving motor energy from the *vagus group*, are therefore furnished with sensory means

§2. Anatomical basis.

of communication through the sympathetic group; conversely, strands supplied with motor energy from sympathetic sources, direct afferent impressions to vagal nuclei. Since we have been made acquainted through experimental methods with sources of motor energy, by following this simple rule, we can acquaint ourselves with the location of the springs of sensory energy.

This rule is of more than passing importance since it furnishes us with information, necessary for the prosecution of our enquiry into the source of muscle sense impressions which are manifested as referred pain in anginous seizures.

The muscular tunic of the œsophagus and cardiac end of the stomach receives motor innervation wholly from the vagus. But strands of the muscular tunic of the cavum are of mixed innervation, certain receiving motor innervation from the vagus, certain from the sympathetic.

So in accordance with the rule, musculo-sensory impressions from œsophagus and cardiac end of the stomach are directed to segments of thoracic and cervical cord. Whereas in the case of the cavum, musculo-sensory impressions are directed from certain strands to sympathetic centres, and from certain others, to vagal centres. So through sympathetic channels, spasm at the cavum may induce referred pain in thoracic regions, and through vagal tracks determine inhibition of the heart. Since motor energy of œsophagus and cardiac end of the stomach is supplied from vagal centres, spasm at the cavum may be expected to produce hypertonus at œsophagus and cardiac end of the stomach, effects of which are felt through referred pain in intercostal and brachial nerves.

In reference to a favourite seat of pain during anginous seizures, namely, at terminals of second, third and fourth intercostal nerves near the sternal border, it is interesting to note that sympathetic filaments arise in corresponding segments of the thoracic cord, and that they leave the spinal canal in connection with intercostal roots derived respectively from those segments and pass into the sympathetic chain. Thence they proceed to posterior pulmonary plexuses. Cunningham's Anatomy, p. 710. When in this situation they join diverging strands of the vagi, as they descend to form the plexus gulæ.

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Section 3. *Dangers to the Heart arising from High Intra-gastric Pressure.*

SUDDEN increases in intra-visceral pressure result in hypertonus of the muscular tunic and thence in the generation of sensible impressions. Except through hypertonic expression, the organ of muscle sense remains silent. Visceral muscle may be cut, crushed, pierced, or scorched, without the provocation of a sign of distress; but every ripple of hypertonus is noted in the sensorium. Upon an increase of intra-gastric pressure, measuring on the manometric scale 12 mm. hydrarg, discomfortable sensations

§3. Dangers to heart from high intra-gastric pressure.

§3. Dangers
to heart from
high intra-
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are felt, and with further elevations of pressure discomfort merges into pain. When hypertonus reaches a high pitch of intensivity, such as that attained when muscle is engaged in spasm, muscle sense impressions are agonising.

In states of health and under the influence of intra-thoracic minus pressure, the thoracic portion of the œsophagus maintains an open channel, closed at either end. Then intra-œsophageal pressure maintains an even balance undisturbed by gusts of high pressure, raised in the stomach. But when the stomach is distended with food or gas, the lower section of the œsophagus is drawn down, and expanding funnelwise is incorporated into the gastric wall. Upon occurrence of this event the œsophageal chamber becomes a diverticulum of the gastric chamber, their atmospheres blend and elevations of intra-gastric pressure are felt by œsophageal walls.

As a result of this mergence, states of high intra-gastric pressure determine œsophageal muscle sense impressions which reach their several destinations in upper segments of thoracic and lower segments of the cervical cord and which are felt, as referred pain, in intercostal and brachial nerves. Through these centres they are potential in the causation of pressor activities of the heart, constriction of muscular tunics of arteries and arterioles, and elevations of systemic blood pressure.

Distension of the stomach, as already described, involves traction upon peritoneal subserosæ, upon pleural subserosæ, upon œsophagus, and hence upon vagal strands incorporated

in the plexus gulæ, which embraces the tube. In view of these remarks, special interest attaches to Rhomstrum's paper, quoted by Sir Clifford Allbutt, in which he says:—

§3. Dangers to heart from high intra-gastric pressure.

“One to two minutes after traction is made on nerve plexuses of the subserosa in upper regions of the abdomen, that is, after the cessation of the pull, pain would get worse and might not subside for several minutes.” Sir Clifford Allbutt, remarking on this observation, says:—“This accords with our clinical experience of angina.”

In Dr. X's diary I find an account of a series of thirty experiments made in 1912 with a view of ascertaining the length of time elapsing between the effort exciting the seizure and the advent of symptoms.

Every night at bed-time Dr. X mounted a flight of twenty-eight stairs on the way from his dining room to his bedroom, and after reaching his destination seated himself and watch in hand waited for symptoms to appear. The time of their appearance was very variable, extending from forty to fifty seconds to seven minutes, the average time being about three minutes. On five occasions attacks occurred which called for a halt before he had reached the top of the stairs. Succession of symptoms was in the following order: (1) A feeling of tightness extending across the front wall of the abdomen from side to side and just below the arch of the ribs such as might have been caused by a string tied round the waist. (2) A desire to eructate flatus attended by inability to throw gas from the chest, (3) Globus. (4) Retro-sternal discomfort merging into pain, (5) Pain at terminals of a series of intercostal nerves at points of outcrop from deep structures to superficial. (6) Pain at upper and inner portions of brachial regions. (7) Intermitting and small expulsions of gas from the chest, followed at length by a voluminous output which brought complete relief with it. Associated with this last event borborygmal abdominal sounds were frequently heard. Delay in appearance of symptoms after exercise observed in this series of experiments corresponds roughly with the delay observed by Rhomstrum.

Gray and Parsons—Arris and Gale Lectures 1912—speak in the same way, of the pain and the inhibitory effects of a drag on the mesentery. They add that “traction on the stomach and œsophagus excites almost a pure vagus inhibition on the heart, and that strong traction may stop the heart.” This is in accordance with the effects of flatulency in cardiac disorder. Professor Keith says the drag on

§3. Dangers
to heart from
high intra-
gastric
pressure.

"mesenteries and ligaments comes into action only when the limits of normal movement are reached."

Stretching vago-sympathetic plexuses surrounding the gall duct is sometimes attended by fatal issues. Abram and Allbutt relate fatal cases. Frerich has noted falls in pulse rate from the normal standard to twenty-eight and even to twenty-one. Allbutt describes death occurring during the passage of a gall stone in the case of a healthy young woman. At the necropsy the stone was found in the common duct; the rest of the body, heart included, was quite healthy.

Traction on the stomach and œsophagus is demonstrated by Gray and Parsons to cause vagal inhibition on the heart and when action is strong, to bring cardiac pulsation to an end. This finding is a corollary of the anatomical configuration of the parts. In view of attachments of vagrant strands of the longitudinal muscular tunic of œsophagus to subserosal tissues of left and right pleural sacs, vagal inhibition is likely to follow traction on the tube. High intra-gastric pressure, in the presence of a distended organ, has an effect of the kind demonstrated by the lecturers. It exerts traction upon œsophagus and upon the m. pleuro-œsophageus, producing almost as a necessary consequence, cardiac inhibition. In a previous chapter it has been shown that in anginous subjects vagus centres are hyper-irritable. This condition renders potentialities for mischief greater in anginous subjects than in those of indifferent disorders.

In view of attachments of the longitudinal muscular tunic of the œsophagus with left and right pleural sacs through vagrant strands, and in view of the contractile

state of gastric walls in anginous subjects, experiments made by Capps and Lewis and remarks upon them by Sir Clifford Allbutt are of much interest to us. They establish the fact that traction upon pleural subserosæ causes cardiac inhibition. These experiments were entered upon to clear up the mystery of the frequency of occurrence of sudden death during operations on the pleuræ. Blungue and Zesas collected reports of twenty-one deaths resulting from incision, from lavage or even from simple puncture of pleura.

§3. Dangers to heart from high intra-gastric pressure.

Capps and Lewis, Cayley, Goodhart, Raymond, Vallin, and others, publish records of perilous events on washing out the pleura or otherwise interfering with this cavity especially near the root of the lung; the danger of this result is exaggerated when the subserosæ is inflamed. Johnson, B.M.J. September 11th, 1909, has demonstrated the fine nerve ramifications in the subserosæ of the chest which he regards as the paths of pleuritic pain.

Subserosæ of the pleura is especially vulnerable, because of the ramifications of dense plexuses of sympathetic and vagus nerves in these tissues. Lennander demonstrated that the afferents are distributed not at the serous surface but just beneath it. Capps and Lewis open their remarks by quoting the experience generally accepted "that in surgical operations about the pleura there still remain a considerable number of cases of sudden death, in which no anatomical lesion can be found, post-mortem, to explain the collapse. . ."

"The effect of stimulation is usually of the cardio-inhibitory kind, the heart is slowed and the pulse tracings

§3. Dangers
to heart from
high intra-
gastric
pressure.

make wide excursions between systolic and diastolic pressures. Respiration is usually slowed and for a moment may be arrested. Occasionally the influence stole rather along the splanchnic vaso-motor division when pulse curves betrayed a rapid decline in both systolic and diastolic pressures. Respiration became shallow and often rapid and abdominal viscera engorged.* Sometimes the pulse became slow even to intermittency, sometimes pressures and output fell together and the pulse dwindled to nothing. As the root of the lung was approached, the cardio-inhibitory effect became so much the more that it would manifest itself promptly even without any inflammatory factor. Then the stimulus was approaching the pulmonary plexus and the pulmonary is connected with the cardiac plexus into which the vagus enters. Brief cardio-inhibitory effects single prolonged heart strokes, such as I have noted occasionally in the pulse of angina, could be called forth almost at will, by stretching the root of the lung or the pericardium."—*Diseases of Arteries*, Vol. 2 p. 479-480.

Particularly instructive are these experiments in reference to those cases of angina pectoris, in which the predisposing cause, namely, segmentary neurosis is associated with pleuritic adhesions.

Œsophageal relationship with vagal nerves is further amplified through contact between this viscus and plexus gulæ. Œsophagus is sheathed by an unyielding cagework of vagal strands, which, with sympathetic fibrillæ, take part in the formation of plexus galæ. The greater portion of the lower moiety of the tube between the bifurcation of the bronchi and the diaphragm is embraced by this plexus. Plexus

*See remarks on engorgement and splanchnic regions in symptomatology, chap. I. sec. 1.

gulæ is connected below with the cœliac plexus, above it is in continuity with pulmonary and cardiac plexuses.

Sympathetic strands from plexus gulæ, en route to thoracic and cervical segments of the cord, *via* the cœliac plexus, are chiefly afferent. They convey muscle sense impressions to the sensorium. They are pain tracks. Vagal trunks are efferent and afferent. In these trunks are included motor strands for intestines, and also afferent strands en route for medullary centres. Through protective contractile action of the muscular tunic of the œsophagus, injury to this plexus is avoided; but in the event of sudden distension of the tube occurring through an unexpected increment of intra-œsophageal pressure, strands of vagi and sympathetic alike are exposed to the liability of stretching.

A close survey of the anatomy and physiology of the gastro-œsophageal track and its neuronie central connexions persuades us to believe that high intra-gastric pressure, in the presence of hyper-irritable segmentary and vagal centres, is an agency possessing potentialities, efficient in the production of anginous seizures, and in the determination of sudden death, which occasionally ends them.

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Section 4. *Gas as the Medium of Resistance.*

FROM observations made in the last section it is §4. Gas, the
apparent that anginous seizures may spring from ^{medium of} resistance.
hyper-tonus at the cavum, from hyper-tonus affecting

§4. Gas, the medium of resistance.

the cardiac end of the stomach, or from retraction of the œsophagus through gastric distension. In the latter case the direct cause of the seizure is traction upon the delicate neuronic plexuses of pleural subserosæ, through the m pleuro-œsophageus and other connecting strands. In either case hyper-tonus of the muscular tunic of the gastro-œsophageal track is the exciting cause of seizures. But hyper-tonus of visceral muscle is not sustained except in presence of resistance. This is a general rule with exceptions. For instance, an exception occurs when centres are extraordinarily irritable, or when a local irritative condition is present, as in cases of inflammation. But commonly the rule holds good.

Hyper-tonus of the uterine wall subsides when the foetus is expelled. Hyper-tonus of the rectum ceases when fæces are passed, and hyper-tonus of the gastric tunic ends when contents of the stomach are discharged. For this reason, when flatus is thrown from the chest or when vomiting occurs, anginous seizures terminate. Gas imprisoned in the stomach, unable to find vent either at the pyloric sphincter or through the œsophageal tube, constitutes the medium of resistance which sustains anginous seizures. When confined gas finds escape, pain and cardio-inhibitory phenomena cease. "Flatulence," remarks Sir Clifford Allbutt, "has been regarded by all writers on angina pectoris as a general, a pressing, and perhaps a cardinal factor, but its significance is difficult to determine."

In the absence of hyper-tonus, gas in the stomach is harmless enough. It is a normal content. There are people of gassy habit who make plenty of gas, belch it up or pass

it on through the pylorus, and remain unaware of its existence. §4. Gas, the medium of resistance. Others, again, swell with it and unbutton trouser and waist-coat at meals, but feel no discomfort except they walk soon after eating or mount stairs, and then the discomfort is of cardio-inhibitory sort attended by a blue countenance and shortness of breath, but painless.

A third type of gassy stomach is found among a few chronic dyspeptics. Gas gathers in the stomach and the waist swells, but nothing is felt until they rise from table and walk. After one hundred yards or so have been traversed, pressure at the chest and sensation of fulness at the œsophagus, as if a large bolus of food had lodged there, are noticed. Discomfortable sensations merge into pain.

If the pulse be now felt, it is small, slow and halting under cardio-inhibitory influence. These latter cases are anginous. The cause of distress is hyper-irritable nerve centres attended by hyper-tonus of the muscular tunic of the gastro-œsophageal track; contractile effort being resisted by imprisoned gas.* After escape of imprisoned gas through either orifice of the stomach, subjects of seizures can walk many miles without experiencing further thoracic discomfort.

The stomach is capable of containing the greatest bulk of gas when in rotund form. When flattened against the

* See Appendix 1.—Protective reflex activities consist in co-ordinate contractile action of parietal layers of muscle and muscular tunics of visceral cavities and tubes. During walking the entire musculature of walls of the abdominal cavity is in a state of hyper-tonus. Diaphragm is drawn down by contraction of its cruræ, and works on a low plane, perineum is raised, and recti-abdominis are highly tonic. Through contraction of the musculature of the walls, containing capacity of the abdominal cavity is reduced, and high intra-abdominal pressure prevails; intra-gastric pressure following suit.

§4. Gas, the medium of resistance.

diaphragm, through pressure from distended colon or other viscera, its containing capacity is lowered, and high intra-gastric pressure results. Anything which increases intra-abdominal pressure, augments intra-gastric pressure, and encourages hyper-tonus.

In experiments made on an anginous subject I noticed that girth at the horizontal plane, mid-way between umbilicus and ziphoid, appendage was reduced by three inches after a walk of one hundred yards, but when a halt was called, and when the patient had rested for two minutes, former proportions were regained. Walking increases intra-abdominal pressure, raises intra-gastric pressure, excites hyper-tonus, and, in anginous subjects, provokes discomfort, pain and cardiac inhibition. Pressure over the abdominal wall has a like effect. Anginous subjects not infrequently fall into seizures when pressure is exerted upon the abdomen. Persons with certain forms of cardiac disorder have suddenly died when stooping, and thereby increasing intra-abdominal pressure. The late Dr. Murchison is reported to have died under a vagal impulse when searching the bottom drawer of a writing table for certain mislaid manuscripts.

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Section 5. *Identification of the Seat of the Exciting Cause.*

DR. Hertz writes:—"On slowly inflating the œsophageal balloon, a sensation of fulness, situated deeply beneath the sternum in the middle line, was felt as soon as the pressure reached 44 mm. of mercury. The sensation did not diminish, even when tension was maintained, for as long as fifteen minutes, and there was no fall in pressure such as would be produced if relaxation of the tone of the œsophagus occurred. The sensation disappeared in three seconds, when the air in the balloon was suddenly allowed to escape. When the balloon was slowly inflated to a greater degree so as to exert a higher tension, the sensation of fulness was increased, but the character remained unaltered." §5. Identification

In each case a feeling was experienced which suggested that a lump had become lodged in the œsophagus. This seemed to be larger and the sensation was more unpleasant the greater the intra-œsophageal pressure. The sensation felt as if it were produced in the middle line, deeply beneath the anterior surface of the body. It was never felt posteriorly. Its level was accurately recognised, the error never exceeding one inch.

At intervals varying in duration from ten to sixty seconds, whilst the balloon remained inflated, a rise in pressure of between 30 and 40 mm. was recorded. This was often associated with an increase in the local sensation of fulness, and occasionally a sensation of uncomfortable fulness was also felt behind the cricoid cartilage, from which it passed rapidly down to the position of the balloon, where it reached

§5. Identification.

its greatest intensity. After a few seconds it disappeared without passing any farther down. The rise in pressure and the accompanying sensation appeared to be due to a peristaltic wave. No rise in pressure and no change in the sensation followed a voluntary act of deglutition, which does not therefore necessarily result in a peristaltic wave.

It seems clear that the presence of a foreign body within the œsophagus gives rise to peristaltic waves originating in the upper end and passing down as far as the foreign body, the waves having the object of dislodging it." *

To prove that uncomfortable sensations and pain experienced during anginous seizures are derived from a gastro-œsophageal source, it is necessary to show that they present characteristic features, peculiar to sensations derived from stomach and œsophagus. Of course in anginous subjects, on account of existing segmentary neurosis, conscious expressions of gastro-œsophageal function are exaggerated. When centres are hyper-irritable, discomfort is translated in terms of pain, sometimes attaining to agonising proportions.

In the presence of segmentary neurosis, sensations deflected from sympathetic channels are felt in intercostal and brachial nerves, and the special and peculiar faculty of zonal localization, possessed by the muscular tunic of œsophagus, becomes highly distinctive; the more so from contemporaneous incidence of tender spots and intercostal spasm and rigidity.

When these considerations are taken into account, sensations of gastro-œsophageal origin experimentally induced,

* Goulstonian lectures on the sensibility of the alimentary canal.

and those present in anginous seizures are homologous in all essential features.

§5. Identification.

Now let us consider marks of identity point by point. During hypertonus of the muscular tunic of the œsophagus, uncomfortable sensations of fulness and pressure are felt in retro-sternal regions. In some instances these sensations are felt deep down in the cavity of the chest, and resemble sensations produced through impaction of a hard crust of bread.

In cases of angina pectoris, complaints are made by patients manifesting sensations, homologous with them. Time and time again I have been told by persons prompted by me to take note of initial symptoms, that seizures begin with uncomfortable sensations of fulness and pressure, in upper and mid-thirds of the chest; sensations which are frequently attributed by them to imprisoned gas, which they have no power to release.

These primary sensations are general. Fulness is felt equally in right and left sections of the thoracic cavity, and not infrequently ineffective attempts are made to expel gas. In many instances sensations of fulness and pressure are attended by a localized feeling, such as might be caused by a bolus of food or other substantial body stuck in the œsophagus. In these instances swallowing is resorted to, and it is encouraged by an excessive secretion of saliva, which gathers in the mouth, and sometimes flows out at corners of the lips. Withal there is a sensation of "qualminess." One person, whose seizure I was witnessing, described

§5. Identifi-
cation.

œsophageal sensations as such as might be caused by a lump of red hot brick in the gullet, and salivary secretion pouring out in great abundance could be seen in the open mouth, spirting from Wharton's duct. The imaginary impacted body was likened by others to a hard crust, by others again to a ball of wind. I find a reference to "globus" in Dr. G. A. Gibson's Morison lectures. He writes:—

"Sometimes a pain is felt in the epigastric region, and not infrequently when this is the case, a sensation of globus analagous to that experienced in hysteria is complained of." Dr. Gibson further remarks that globus, hiccough and disphagia are frequently found occurring in the same anginous subject. Sir Clifford Allbutt, in *Diseases of Arteries*, Vol. 2, p. 501, writes:—"It has been pointed out that globus of wind, or spasm, in the œsophagus, or at the cardiac orifice of the stomach, may simulate slight anginous attacks."

Bucquoy, quoted by Sir Clifford Allbutt, relates a case of death from angina pectoris, occurring after some hours of distress interpreted as globus.

The characteristic form of anginous pain bears marks of œsophageal origin. It springs directly from those discomfortable sensations described as globus, fulness, and intra-thoracic pressure. These primary sensations merge through rapid gradations into crushing, vice-like, bursting sensations, which have no parallel in pain felt at other parts of the body and from other complaints. They are characteristic and distinctive of sensations of gastro-œsophageal origin.

As far as I am aware, from no viscus, except œsophagus, can sensations such as are associated with swallowing

emanate. No other viscus besides cesophagus is the seat of §5. Identification.
 "globus."

Muscle is the sole organ of sensible expression possessed by viscera, and sensations come into being when muscular tunics of viscera are hypertonic, and at no other time whatsoever. No sensation emanates from muscle while hypotonic or atonic. But it must be remembered that atonic muscle falls into spasm more readily than tonic muscle, and when spasm occurs, pain is felt.

Viscera are sensible in a manner after their own kind. Under hypertonus the muscular tunic of the bladder gives expression to sensations of fulness and pressure, and a desire to expel super-abundant contents. Under hypertonic conditions, rectum and stomach display sensations and desires like those springing from the bladder.

In other particulars, however, rectal and gastric sensations are of a distinctive order. The muscular tunic of the rectum differentiates between solids and fluids, fluids and gas. Whereas the muscular tunic of the stomach, as contrasted with that of the rectum, possesses little differential cunning but is endowed with another faculty which expresses itself in nausea, yet, like the rectum, it generates sensations of fulness and pressure and a desire to relieve tension which it satisfies through expulsion of gas, fluids and solids.

Impeded function of the heart is recognised by breathlessness and gasping respiration, but these sensations are not from the heart, for the myocardium is not in touch with sensory tracks. Under hypertonus, the muscular tunic of the

§5. Identification.

œsophagus gives expressions to sensations. Certain of these are similar to those of the rectum. Like the muscular tunic of the rectum it differentiates between gaseous and solid bodies and it recognises tension, and degrees of hardness of bodies. In addition, it possesses a faculty peculiarly its own; a form of endowment due to its sectional or zonal innervation. It is conscious of the situation at which hypertonus is occurring. When a hard body becomes impacted in the œsophagus, hypertonus at the situation occurs, and discomfortable sensations are felt at particular and corresponding areas of retro-sternal and adjacent retro-costal regions.

Afferent sensible innervation of the œsophagus is sympathetic. Sensible innervation is provided by the sympathetic group and innervation from the sympathetic system is segmental. Consequently, discomfort felt during impaction of a solid body in the œsophagus is zonal, a fact which explains the faculty of precise localization of hypertonus, occurring in the muscular tunic of the tube. So in angina, when discomfort is felt at the lower, the upper or the mid-third of the sternum we are conscious that hypertonus is occurring at corresponding sections of the œsophageal tube.

But hypertonus of the muscular tunic, the organ of sense of the œsophagus is not excitable by impaction of solid bodies alone; it is brought into play by any form of intra-œsophageal high pressure, whether the agency be solid or gaseous. Nay, unprovoked by any local cause, it is excitable by central nervous stimulation. For instance, it is responsive to reflex impulses from the stomach or to reflex impressions

from emotional sources, such as obtain in the globus of joy, sorrow, fear and hysteria, and indeed in all forms of mental excitement. Moreover the same reply is provoked by strenuous muscular exercise. Nevertheless whatsoever be the nature of the exciting cause, whether it be material and local or physiological or psychological; forms of sensation generated are the same; namely, sensations of fulness and pressure and sensations such as are produced through impaction; all of which sensations are subject to localization.

\$5. Identification.

These symptoms occurring during the anginous seizure makes us confident, that muscular tunics of stomach and œsophagus are seats of spasm. Referred pain located at one at another, or at several distributary zones of intercostal nerves, offers proof of the source of its origin. Sometimes pain is seated at ziphoid cartilage, sometimes in mid-sternal zones, sometimes at the synchondrosis. These sites may be shifted during the course of a seizure, and at the next seizure another site of incidence is selected.

This disportive method of choosing localities of incidence, indicates that the affected viscus traverses many zonal regions and is in afferent connexion with 2nd, 9th, and intermediate segments of the thoracic cord. The viscus from which these sectional and painful expressions of spasm are emanating, is necessarily an elongated muscular viscus, in other words a tube, the chief function of which appertains to swallowing. The sole organ which answers to these conditions is the œsophagus.

§5. Identification.

It may be added that the account given of afferent connexion, between sections of the muscular tunic of the oesophagus and corresponding segments of the thoracic cord is confirmed by the fact that Dr. Hertz's subject of experiment was proved to be conscious of the precise situation at which hypertonus was occurring.

Sir Clifford Allbutt speaks of "the associated gastric phenomena found in angina" and regards angina as "a cardiac vascular lesion aggravated by gastric reciprocity." In confirmation of this hypothesis he states that gastric phenomena are found not in angina only but in almost all diseases and disorders of the heart. With the latter part of this statement my experience is wholly in agreement, and in a course of treatment of cases of this class, directed exclusively to the stomach, I have frequently noticed that the cardiac disease has vanished. This is a common experience. I have noticed also the same result to occur during the treatment of the angina pectoris major, as well as in that of the angina pectoris minor.

It is not an uncommon error among clinical observers confronted by parallel morbid processes to misinterpret the relationship between cause and effect; to mistake parent for offspring. When the heart is violently disturbed, even unto death, the silent voice of the stomach passes unnoticed, or when it is noticed, it is regarded as secondary and dependent upon the cardiac disorder.

Functional expressions properly belonging to one viscus cannot be imitated by another. Consequently during

anginous seizures, when we find sensations of nausea, pressure and fulness at the chest occurring, attended by desires to retch and to expel flatus, when we observe globus and the full complement of symptoms associated with œsophageal function, we cannot doubt the existence of hypertonus of muscular tunics of stomach and œsophagus. In fact, then we know that these symptoms are expressions of functions peculiar to these viscera and that they do not appertain to the complement of the heart nor to that of any other viscus whatsoever.

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*Section 6. Schema of Reasons in favour of the Hypothesis,
that the Seat of the Exciting Cause of Anginous Seizures
is located in the Muscular Tunic of the Gastro-œsophageal
Canal.*

ALTHOUGH pain may be caused through traction §6. Summary.
upon investments and mesenteries of organs and
upon subserosal structures, yet except in the matter
of location this form of pain bears no characteristics of
differentiational value. Whereas special sensory expressions
springing from muscular tunics of organs indicate the
functions of the viscus whence they spring. As anginous
pain possesses characteristics particular and peculiar to its
own individuality, it is concluded to be expressive of an
outraged muscle sense.

2. Anginous pain of intensive type resembles such as
might be induced through over fulness to bursting point of a

§6. Summary thoracic viscus, and it is suggestive that relief might come if gas were expelled from the chest. It is not suggestive of centripetal pressure but centrifugal. It is frequently described by those who suffer from it as a sensation of tightness. When in extremity, the expansile force would appear to the sufferer to exert itself upon the whole wall of the thoracic cavity. But before it reaches its extremity, and especially at inception, characteristic sensations of gastro-oesophageal origin are in evidence. They are manifested by nausea, by desire to eructate gas and by globus. These special and finer sensations merge through gradations of discomfort into the intensive type of pain already described.

3. Muscle sense impressions cannot be generated by any other means except through hypertonus. In the case of oesophageal, muscle sensations are felt at least primarily in the segmentary zone or zones in which hypertonus is occurring.—See section 5. Since anginous pain is felt in zonal regions traversed by oesophagus, and since its manifestations are sometimes limited to one zone, sometimes to another, in upper, in lower or in mid thoracic regions, there is reason for the argument that it can be caused by no other viscus except oesophagus.

4. Anatomical features of the muscular tunic of the gastro-oesophageal portion of the alimentary canal, its relations, its functions and the method of its innervation, are such as especially to equip it, as an efficient agency in exciting anginous seizures.—See section 2.

5. This muscular tunic is in afferent connection with those segments of the cord which serve the myocardium with presser energy. A section of 'the muscular tunic of' the cavum pylori is in afferent touch with vagal nuclei in the medulla; under spasm this section is an efficient instrument of cardiac inhibition.

6. It is acknowledged by all writers of authority on the subject that gas imprisoned in the stomach is a medium through which anginous seizures are started. This statement, confirmed by Sir Clifford Allbutt, has reference to angina major and to angina minor. No other sheet of muscle except the cardio-arterial possesses qualifications of location and bulk to offer an alternative seat to the exciting cause, and this agency is debarred as a claimant on account of reasons given in sections of chapter 6. 6. Summary

7. Anginous seizures are sustained by gas under pressure in the stomach, and they end when imprisoned gas is liberated.

8. Pain from a stomach disordered by a heavy and indigestible meal is commonly felt at the synchondrosis; occasionally extending across the chest to the left, right or to both arms. It is not infrequently attended by cardiac disturbance and arrhythmic phenomena. It contrasts from that of the anginous seizure only in the matter of degree. In the presence of segmentary neurosis such attacks might properly be described as anginous.

9. Anatomical structure of the gastro-cæso-phageal portion of the alimentary canal, its musculature and the method of its innervation is such as readily lays itself open to the production of symptoms such as are experienced in anginous seizures.

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Chapter IX.

Remote Exciting Causes.

- Section 1. Effects of Duodeno-caval Reflex Function.
- Section 2. Effects of Colo-caval Reflex Function.
- Section 3. Effects of certain other Abdominal Reflex Impressions.
- Section 4. Effects of Imprisoned Gas.
- Section 5. Effects of Muscular Exercise.
- Section 6. Effects of Emotional Disturbance.
- Section 7. Effects of the Left-sided Pose.
- Section 8. Effects of Cold.

Section 1. *Effects of Duodeno-caval Reflex Function.*

§1. Duoden
caval reflex.

RECORDS of a number of sudden deaths occurring during the passage of gall stones are recited by Sir Clifford Allbutt, one of which came under his personal notice. At the autopsy the stone was found in the common duct; the rest of the body, heart included, being quite healthy. Dr. Pinching, of Gravesend, reports a case of death from gall stone in a healthy woman aged fifty-seven. The stone was found in the duct; no other

cause of death was discovered. Dr. I. H. Abram also §1. Duodeno caval reflex. mentions a case of sudden death where a gall stone was in passage. In 1904, Conti noticed reflex effects on the heart caused through the passage of gall stones. In several cases coming under my own cognisance, the heart was profoundly depressed. Frierichs, during biliary colic, has noticed in two cases pulse to fall as low as twenty-eight and twenty-one beats per minute respectively.

In my own practice I have met with cases of biliary spasm occurring in persons of anginous habit. In these instances attacks beginning as biliary colic were observed to merge into seizures which presented all symptoms characteristic of anginous disease. From five to ten minutes after attacks started, pain which had been limited to epigastrium, crept up behind the sternum and reaching the synchondrosis radiated to shoulders, arms, back and neck. Meanwhile waves of diffusive chilly and sickening sensations swept abdominal and thoracic cavities. This latter form of sensation is associated with a desire to retch to eructate gas and to vomit.—Sec. 4, chap. 2, p. 32.

Early in the year 1919, Dr. X., an anginous subject, was attacked by cholo-cystitis which followed in the wake of catarrhal influenza. Fæces lost colour, urine was darkened by biliary pigments, and jaundice was marked. The illness lasted six weeks during which time temperature maintained an elevation of one to two degrees above normal. Although at early periods of the illness symptoms were identical with those associated with the passage of gall stones, no stones were ever found.

§1. Duodeno-
caval reflex.

After occurrence of a series of seizures resembling those usual in cases of gall stone, the type altered and assumed the shape of the anginous seizure. During the last week of the illness, which ended suddenly after a pint of green bilious matter had been vomited, attacks were frequent and persistent; anginous pain occurred during eating, on going to stool, and upon the slightest muscular effort. Anginous seizures were attended by cardiac disorder, alarming in kind. At first pain was relieved by administrations of nitroglycerine, antipyrin and aspirin, but these drugs losing efficiency became useless. Fortunately morphia retained its good repute. In one of my cases of angina pectoris, namely, in that of a stout man aged sixty-five years with a flabby heart, sudden death occurred during an anginous seizure, which came on while a gall stone was in passage.

In reference to the grafting of the anginous seizure upon the stem of the gall stone attack, I would call attention to a sensation of a sickening character, associated with a desire to retch and to expel gas from the chest. This is common in biliary colic and, also in angina, it is a special gastric sensation which cannot be generated by any tissue other than the muscular tunic of the stomach. It usually comes into evidence with a category of chilling, indefinable sensations which disregard anatomical boundaries and spread in waves over shoulders, neck, thorax and abdomen, and are even felt at the dorsum of the thighs, in the ankles and at the toes. In the chapter on pain, these sensations are described under the name of diffused sympathetic sensations.

In this connection it is remembered that the muscular tunic of the stomach and that of all hollow viscera are

sensory organs, and that sensations from these tunics come only under the recognition of consciousness when they are in states of high hypertonus. So when desires to retch and eructate gas are felt, with whatsoever other sensations they are mingled, we know that they proceed from the stomach and that they indicate hypertonus or spasm. This is so, for these desires are generated in response to distress of the muscular tunic of the stomach.

§1. Duodeno-caval reflex.

Therefore it is concluded that during the passage of gall stones a duodenal-caval reflex impulse is engaged in the production of symptoms, and that during the passage of gall stone in anginous subjects the occurrence of anginous symptoms is not an altogether unexpected outcome. Even in the absence of anginous pain, inhibitory action set on foot through excitation of tetanic spasm in the muscular tunic of the cavum furnishes an explanation of the occurrence of sudden death while gall stones are in passage.

Duodeno-caval reflex function is the instrument of intercostal shoulder pain, frequently complained of in cases of biliary colic, and which was explained by Hilton in his lectures on rest and pain as due to peripheral connexions existing between intercostal and great splanchnic nerves. In reality these connexions are central.—See appendix 2.

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Section 2. *Effects of Colo-caval Reflex Functions.*§2. Colo-caval
reflex.

THERE are two forms of seizure which are seldom mentioned in anginous literature, but which are of more than passing importance to us in determining the seat of the exciting cause of anginous seizures ; I refer to seizures which come on during food taking, and seizures which affect persons subject to them before, during and after stool. I do not think these forms of attack are uncommon, because in my limited experience I have met with several examples, all of which have occurred in cases of long standing.

In the former type of case the subject of it feels quite well when he sits down to eat a meal and views with appetite and satisfaction dainty dishes set before him. But he has scarcely swallowed more than one or two mouthfuls when he is seized with a very uncomfortable sensation in the chest, which makes him hesitate before taking any more. He has a feeling of nausea and a sensation of fulness, suggestive of impaction of a bolus of food in the gullet. Appetite leaves him, indeed the prospect of eating what is on his plate, disgusts him and he toys with his fork and knife. Sometimes a gust of gas rises and is expelled ; all uncomfortable sensations vanish with the flatus, and then he goes on with the meal, but without appetite. For the sake of appearances he takes what is put before him, nevertheless he is glad when opportunity offers means of escape from the table.

More often, however, attacks do not pass off so easily ; discomfort merges into pain which involves the upper part of the

chest, shoulders, back and arms, and passes upwards to the jaws. Attacks can generally be relieved by swallowing a few mouthfuls of hot whiskey and water. Seizures may be occasional, only, or they may come at every meal. They lead to distaste for food, little is taken during the day, and even the bare thought of food brings with it loathing and fear. This form of attack is generally contemporaneous with frequency of attack from other causes of excitation, for instance, walking.

§2. Colo-caval reflex.

Attacks coming on in association with defæcation present a symptomatology similar to that just described, and are often found occurring in the same subject. Usually symptoms are first felt about five minutes after stool and they are hastened by the labour of adjusting clothing and by walking from the lavatory to sitting room or bedroom. They are frequent in cold weather, and exposure of parts during defæcation may have something to do with increased frequency. Sometimes first symptoms appear during stool, especially when action is prolonged. But it is quite certain that they are not caused by straining at stool. They are not as frequent when necessities of the situation demand straining efforts, as when the motion is loose. Indeed I have been told of instances when incipient symptoms have disappeared as soon as straining begins. On certain occasions the seizure is the first event in a train ending in defæcation.

Dr. X. states that after breakfast while sitting quietly in his chair looking over correspondence, seizures of pain in the chest had begun, followed five minutes later by a call to stool. Thoracic discomfort being the first intimation of the event. This phase negatives an argument which more than once I have heard stated, that seizures occurring in connexion with

§2. Colo-caval reflex.

defæcation are determined through output of muscular effort engaged in expulsatory action. This adventitious form of seizure is invariably attended by a desire to eructate flatus, and subsides when gas is expelled. It results from a colo-caval reflex.

Association existing between colonic seizures and gastric symptoms, as far as I am aware, is explicable on the inference that a colo-caval reflex is in being. This inference is confirmed by cases not uncommon in which disturbed gastric conditions, and even anginous manifestations are associated with stricture of the descending colon. In one such case under my notice, anginous symptoms, complicated by attacks of paroxysmal tachycardia, were of frequent occurrence; retro-sternal pain of the characteristic crushing type being intensive. After removal of a constricting carcinomatous band from the descending colon, anginous symptoms and arrhythmia ceased, and had not recurred when enquiry was made two years after operation.

The following examples of the association between anginous seizures and colonic activities, are taken from Dr. X.'s diary. For nine years Dr. X. had suffered from anginous seizures, before pain was felt at times of defæcation and during food taking. On September 19th, 1917, the following note appears:—

“This is a season of frequency of seizures. Lately, when walking, I have stopped as many as seven or eight times in one hundred yards and waited for pain to subside. If gas be thrown from the chest, pain ceases, but on starting again, it returns. At night, on going to bed, pain comes on, not

while I am on the stairs, but soon after I have seated myself in my room.” §2. Colo-cava reflex.

“Before defæcation, even before I am conscious that defæcation is nearing, pain at the synchondrosis appears. If gas be thrown from the chest, as often it is, pain ceases. If the bladder be emptied a degree of relief is felt. When contents of the rectum are expelled, pain vanishes. Also now when I swallow hot fluids, a burning pain in the epigastrium is felt. Yet I can remember as late as a month ago, fluids as hot as those which now give discomfort, could be taken without giving rise to any gastric sensation.”

“Yesterday I noticed pain at both sides of sternal synchondrosis, in second and third intercostal regions, which disappeared almost instantly, after a large volume of gas was expelled from the rectum; pain was attended by nausea. For several days past I had been subject to similar symptoms immediately before gas from the rectum or water from the bladder was expelled. The same sensations felt before stool, were also felt after stool. In both instances expulsion of gas from the stomach gave relief.

Ten days later Dr. X. writes :—

“Time and time again I have noticed a sense of disability almost immediately after defæcation, frequently attended by retro-ziphoïd and retro-costal pain, just outside left nipple line. Both sense of disability and pain are dispelled on eructation of gas.”

From this time to February, 1918, notes relating to pain associated with defæcation appear in Dr. X.'s diary. On one occasion he writes :—

“A desire to empty the bladder and rectum often accompanies the desire to expel flatus from the chest. Satisfaction of this desire dispels pain from the chest.”

§2. Colo-caval
reflex.

On another occasion, namely, on November 28th, 1917, he writes:—

“On awakening at six o'clock this morning I noticed much flatus was passing from the rectum, and soon I felt a desire to go to stool. On getting out of bed discomfort was felt in upper part of the chest, on the left side near the sternum. On reaching the lavatory, discomfort merged into pain, felt in line of the left anterior axillary fold. A stool was passed without strain. Yet pain in upper part of chest increased rather than abated. After five minutes or so it subsided. Continuance of symptoms after expulsion of gas from the chest and release of gas and fæces from lower reaches of the bowel has occurred on this occasion and on many others during this month. It is a new experience not noticed before.”

On December 15th, 1918, when a season of acute segmentary neurosis was about to recur, Dr. X. writes:—

“One hour after dinner I felt nausea, and gas in considerable quantity had collected in epigastric and hypochondriac regions, imparting a sensation of tightness and general discomfort. No belching occurred. Soon after these sensations had reached their height, sensations at the lower bowel, felt chiefly in hypo-gastric and umbilical regions forced attention to them and called me to stool. A loose motion was passed without strain, and thirteen minutes afterwards eructations releasing small quantities of gas, occurred. But discomfort from tension in upper abdominal regions still remained unrelieved. Now began thoracic pain of a severe type. It was bilateral in post-nipple, perpendicular planes, at the level of third, fourth, and fifth intercostal spaces.”

On December 20th, he writes:—

“Although no aperient medicine had been taken, I had a call to stool about seven a.m. The call was urgent. A loose

and partially liquid stool, with large quantities of gas, was discharged without strain whatsoever. Three minutes afterwards, pain was felt at bilateral regions of the thorax in anti-axillary, vertical planes, at fourth and fifth intercostal spaces. Retro-sternal and deep pains were also felt, the latter deep down in the thorax was associated with œsophageal sensations resembling such as might be caused by impaction of a hard bolus of food. Pain extended to interscapular space and to regions of humeral insertions of deltoids. The seizure lasted about five minutes and gradually left me.”

§2. Colo-cava
reflex.

A second stool was passed at ten a.m. with but little thoracic discomfort following. A third at three p.m. was quite free from discomfort. December 26th, 1918, Dr. X. writes:—

“After taking one teaspoonful of glaubers salts at bedtime I went to sleep. At six a.m. I received a call to stool. Easy full motion was passed without strain. It was followed by pain at third bilateral costo-chondroid articulations. A tender spot was afterwards felt in the left space, but not in the right. The attack of pain coming on four minutes after stool lasted seven minutes. During the attack this was the order of the sequence of events:—

(a) A call to stool.

(b) Evacuation.

(c) Sensations of fulness in the chest, discomfortable deep seated and likened at the time to such as might be caused by impaction of a large bolus of food in the œsophagus. An insatiable desire to expel gas from the chest attended it.

(d) Pain retro-sternal and diffusive and also pain readily localised bilaterally at 3rd intercostal spaces.

(e) Eructation of gas in quantity attended by partial relief from pain.

(f) Borborygmal sounds from left hypochondrium; a continuous rattle.

§2. Colo-caval
reflex.

(g) Subsidence of pain.

(h) Tender spot over left 3rd. intercostal space remains ; pain returns again in the same region after walking from lavatory to bedroom. and again relief follows eructation of flatus." On December 27th, Dr. X. writes :—

"At 7.30 call to lavatory. Loose motion, absence of effort or strain. Three minutes later syndrome of sensations resembling those which were stated as occurring yesterday. Same regions affected and again complete relief after borborygmal sounds had been heard and still again recurrence of symptoms after walking from lavatory to bedroom." A distance of twelve or fourteen yards.

It is here remarked that seizures in the one instance resulting from defæcation, and in the other from walking, produce precisely similar gastric and thoracic symptoms.

Sensations special to the musculo-sensory organ of the stomach and sensations special to the musculo-sensory organ of the œsophagus, referred to in examples just described, suggest that muscular tunics of these organs act as intermediaries between colonic and thoracic phenomena, and point to the existence of colo-caval reflex function, to which pylorus and secondarily œsophagus respond.

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Section 3. *Effects of other Reflex Abdominal Impressions.*

HOLLOW muscular viscera of the abdomen and §3. Other abdominal reflexes.
 pelvis are closely associated through reflex con-

nexions. Hypertonus in one organ induces hypertonus in others. For instance, persistent vomiting occurs during early pregnancy, and during certain forms of dysmenorrhœa, when hypertonus affects cervix uteri, and ceases when this state of the neck is reduced through divisions of constraining strands of muscle. It also attends spasm at the neck of gall and urinary bladders, and it is excited by irritable rectum. I remember the case of an adult, in which persistent sickness abated with the discharge of a colony of thread worms.

Now if we trace upwards the dense reteform groups of sympathetic nerves with segmentary afferent and efferent connexions which are known as pelvic, hypogastric, aortic, and solar plexuses, and follow the chain further, and into supra-diaphragmatic regions, where it reappears under the name of œsophageal, pulmonary, and deep and superficial cardiac plexuses, and when we recognise that functions of all organs lying in this sympathetic track are disturbed during misbehaviour of one of them, we conclude that such sympathetic connexions we have noticed make this sequence of events not only probable but certain.

§3. Other
abdominal
reflexes.

In anginous subjects seizures become more frequent during attacks of appendicitis. In two instances I have known them to be fatal.

In one, death occurred from an anginous seizure, just after an operation for appendicitis had been decided upon; the patient not having then, as yet, been made acquainted with the decision. I did not see him during his last illness, but I had attended him several years previously, during a series of seizures of abdominal type but not severe. His heart was large and fatty, and he was a flatulent subject. He was of studious habits, took little exercise and had grown fat.

In the second case, appendicitis came on after a long period of quiescence from anginous attacks. Seizures did not recur until the patient had taken to bed on account of appendiceal trouble. His heart was sound, but his digestive powers were weak, and he took badly to the sloppy food given him while in bed. Afterwards, when too late, I regretted that I had put him on a milk dietary, for I knew, when I ordered it, that it was likely to breed flatulence. Nothing but adherence to a scanty, well selected and solid dietary had previously helped in securing him freedom from seizures. I was over-ruled by the appendiceal trouble. Moreover, I was lured by the consideration that he had been free from seizures for several months.

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Section 4. *Effects of Gas.*

HIGH intragastric pressure is induced either by a §4. Effects of gas.
reduction of the containing capacity of the stomach
or by addition to the volume of its contents.

Additions to the volume of gastric contents are made by food taking, and by ebullition of gas through perverted biochemical metabolism. Reduction of containing capacity is due to sudden alteration in shape, from a rotund, to a flattened contour, produced through pressure exerted either by butting from viscera, or by increase of intra-abdominal pressure. Moreover, reduction of capacity is determined through hypertonus of the gastric wall. Hypertonus of the gastric wall occurs when intra-gastric pressure is raised suddenly. In this case, increase of intra-gastric pressure augments intensity of hypertonus, and increase of hypertonus raises intra-gastric pressure. Hypertonus and hence intra-gastric pressure is raised through reflex activities.

We shall now consider the rôle played by gas as an agent in the initiation of hypertonus. A sudden increment to the volume of residual gas excites hypertonus in the muscular tunic.

When the quantity of residual gas is already large, a small increment is sufficient to raise intra-gastric pressure. When segmentary centres innervating the muscular tunic are hyper-irritable, hypertonus occurs at lower pressure, than

when they are healthy, consequently in subjects of anginous habit a small increment induces spasm in the gastric wall. Swallowing food stuffs and drinks from which gas is readily evolved through biochemical action is an efficient cause of seizures.

That gas may be evolved rapidly from suitable food stuffs, through biochemical action was demonstrated in the case of Mr. I., who a few years later than the incident related below died in a seizure. A small quantity of the residual contents of his stomach had been drawn off through a tube and added to a bottleful of sweetened milk. The bottle was corked, and left in a warm place. The next morning on going to fetch the specimen for examination I found the bottle burst and the specimen lost. This incident gave me sufficient grounds for holding gas, at a higher estimate, than I had done before, as an efficient agent, in the production of intra-gastric pressure, hypertonus and spasm.

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Section 5. *Effects of Exercise in the Production of High Intra-gastric pressure.*

§5. Effects of exercise.

AS long as a subject of gassy stomach remains seated at table after a meal, gastric symptoms seldom trouble him, but if he rise from his chair, walk across the room or go upstairs, a sensation of pressure in sub-ziphoïd and

retro-sternal region is evoked, desire to eructate flatus is felt and cardiac symptoms are manifested. This phenomenon is interpreted upon the hypothesis that walking excites hypertonus of the muscular tunic of the stomach, which in turn provokes symptoms. Be it always remembered in this connexion that in persons of flatulent habits the cardiac orifice of the stomach is overt and gastric, and œsophageal atmospheres are merged. During the anginous habit when segmentary centres are hyper-irritable, intensive hypertonus is readily induced, and from painless attacks associated with the gassy stomach, painful seizures of the angina pectoris are evolved.

§5. Effects of exercise.

With an open cardiac orifice, high intra-abdominal pressure is instantly transmitted to the œsophageal atmosphere and with every step forward intra-œsophageal pressure is raised.

With the view of ascertaining the effect of walking upon intra-abdominal pressure, I made a series of experiments upon a pot bellied anginous subject, taking measurements of abdominal girth when he was lying in a prone position, again when he was standing, and again immediately after he had walked one hundred yards. A fourth measurement was also taken after a halt of one minute's duration.

The standing posture reduced girth by one inch. The reduction amounted to three inches after walking. But after a minutes rest girth had increased by one inch, and was still continuing to increase. The experiment was repeated many times with similar results.

From this experiment it is inferred that intra-abdominal and hence intra-œsophageal pressure is increased by walking, and consequently when segmentary centres are subjects of hyper-irritability, and œsophageal muscle is correspondingly hyper-irritable, walking exercise by increasing intra-abdominal

§5. Effects of and intra-gastric pressure is likely to promote spasm of the exercise, gastro-œsophageal muscular tunic and in its train anginous pain.

In an anginous subject suffering from a protruding umbilical hernia, the tumour was noticed to expand and become tense when he walked, a phenomenon indicating increased intra-abdominal pressure.

Exercises which induce hyper-tonicity of the abdominal wall are instrumental, in a greater measure than other forms of exercise, in the provocation of anginous pain. In the case of Dr. X., pain comes on after a walk of one hundred yards or less. Yet he cycles several miles on level ground without exciting thoracic discomfort. The explanation of these contrasting phenomena is found in the difference of effect produced by them upon tonicity of the abdominal wall, and hence upon intra-abdominal pressure.

Walking raises intra-abdominal pressure to high degrees of elevation, whereas during cycling, intra-abdominal pressure is little affected. The cyclist leans over the handle bars, and through their support, the weight of the upper part of the body is sustained; abdominal walls remaining meanwhile soft and compressible, permissive of low intra-abdominal pressure, but during walking, abdominal walls are contracted and excite pressure.

Instances have come under my notice, in which anginous subjects have been in the habit of cycling ten to twenty miles a day, without suffering from thoracic pain, whereas the same persons are unable to walk one hundred yards and remain free from attacks. Dr. Oliver, of Harrogate, in his work, introduces

examples of the effect of the two forms of exercise upon systemic blood pressure. Half-an-hour's walk, taken by a sound, healthy adult, raised pressure 30mm. hydrarg., whereas cycling, during a period of the same duration, and in the same subject, produced no elevation whatsoever. These observations are of practical value as guides in the treatment of cardiac and arterial disease, as well as in the treatment of angina.

The effects of strenuous exercise upon a full stomach in the case of young and healthy adults, is emphasised in examples of sudden death, recorded from time to time. The effects of walking on the anginous subject under similar conditions are well known.

In the case of Dr. X. I made a series of experiments, referred to in another chapter, upon the effects of different forms of dietary, wherein it was noticed that taking sweet and starchy foods, and sweet drinks, caused early and increased frequency of attack when walks were taken after the meal.

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Section 6. *Effects of Emotional Disturbance on the Production of High Intra-gastric Pressure.*

IN Dr. X.'s diary are notes on the effects of mental excitement and emotional disturbance upon intra-gastric pressure. While still seated at table after indulgence in wine and sweet pastries at dinner Dr. X. was accustomed to

§6. Effects of emotional disturbance.

§6. Effects of emotional disturbance. unbutton his waistcoat and trousers band to give room for expansion of a gas laden stomach. This precaution having been taken, no discomfort was felt from the accumulated volume of imprisoned gas, except when he permitted himself to be drawn into political arguments or into other discussions which caused excitement or emotional disturbance. If, however, he did become excited, while his stomach was distended with food and gas, one of two events occurred, either gas in large volume was eructated, or anginous symptoms manifested themselves.

A person prominent in the political world told me that it was his accustomed habit to refrain from wine, pastry and sweet foods, at public dinners on account of discomfort caused through neglect of this rule. On several occasions indulgence in these articles of dietary had resulted in gassy manifestations, which had rendered utterance almost impossible, and his speech had to be cut short in obedience to gastric impotency. An eminent surgeon informed me that for a similar reason he refused to operate soon after luncheon or dinner. In both instances emotional disturbances acting upon unstable segmentary centres, produced hypertonus of gastric wall which in the presence of a gassy stomach resulted in symptoms.

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Section 7. *Effects of the Left-sided Pose.*

DR. X. informs me that he cannot lie on the left side §7. Effects of
for long without exciting anginous pain, and state- left-sided
pose.

ments to the same effect have been made to me by other persons of anginous habit. At seasons of frequency of attack, this form of inability is more marked than at seasons of quiescence. Popular opinion assigns the inability to pressure on the heart, resulting from the gravitation of viscera upon it. This explanation of a very common phenomenon is not convincing. The heart is slung in an unyielding cage of bone, and the diaphragm which forms the floor of the cage is in great measure unyielding also. During the autopsy on a case, in which this phenomenon was prominent during life, I exerted considerable pressure upon the aponeurosis of the diaphragm, but failed to bring effective pressure on the heart. Consequently, the effects produced upon the heart, through direct pressure from below, cannot rationally be regarded as the cause of the phenomenon.

Pressure excited on a rotund stomach, through butting of abdominal viscera against it, is an efficient cause of cardiac distress. The gas-laden stomach is at the highest pitch of its containing capacity when in a rotund form. It is at its lowest when flattened against the cushion of the diaphragm. Consequently, during the left-sided pose, when abdominal viscera

are gravitating upon the stomach, its containing capacity is reduced, and, if full of gas, intra-gastric pressure rises, hyper-tonus of the muscular tunic is generated, and in the presence of hyper-irritable, vagal and sympathetic centres, cardiac inhibition, and pain occur.

When the status anginous is pronounced, patients lie on their backs with shoulders raised; they can neither rest upon left side nor right. Inability to lie on either side finds rational explanation in the recognition of tenderness of brachial nerves in anginous subjects, and the readiness with which attacks are produced by pressure on them. In instances of this kind, if the arm affected be thrust forward, and the weight of the trunk be supported by the shoulder, the left or right-sided pose may often be retained without pain recurring. That is to say, if the arm be drawn sufficiently forward and outside the area of pressure incidence.

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Section 8. *Effects of Cold.*

§8. Effects of cold.

COLD weather is badly borne by anginous subjects; several persons have told me they feel bilious during frosts and are troubled by "qualmy" sensations. Qualmy sensations are common enough among anginous persons, and the advent of qualminess is often synchronous

with the start of seasons of frequency of anginous seizures, ^{§8. Effects cold.} when moderation of exercise is specially called for. Dr. X. tells me he feels thankful when a frost breaks, for as long as it lasts seizures are readily excited. Exposure to a cold wind, however warmly clad he be, induces discomfortable sensations in his chest.

There is something paradoxical about cold as a remote exciting cause, because I have known persons particularly affected by its influence when they walk, yet able to take cold baths and sluice their faces, necks and arms with cold water and feel the better for it. I have not yet met with cases in which cold alone excites attacks, but I know many subjects of the anginous habit who are particularly liable to seizures in cold weather and who are fairly free from them on warm days. Sir Clifford Allbutt quotes a case in which cold sheets excited attacks when the patient was in bed. Anginous subjects have told me again and again that they go to bed in socks and drawers which they have worn during the day rather than suffer exposure by taking them off. To avoid cold sheets many persons of anginous habit sleep between blankets.

The hands of anginous subjects are extremely sensitive to coldness of atmosphere and they remain cold in spite of exercise. A degree of coldness described as painful coldness is not infrequently complained of. The patient who can walk 100 paces on a warm day without exciting a seizure; upon a cold day is attacked before he has covered a third of the distance.

Chapter X.

Selected Cases of Angina Pectoris.

Selected cases
of angina
pectoris.

DURING an illness lasting many years in the case of Miss F., frequent observation of the hyper-æsthetic symptom was made, and results of examination were recorded on a figure diagram. I select this case from a number of others on account of unusual prominence of inter-paroxysmal symptoms.

Tender spots occupied points of outcrop of intercostal nerves, which while the illness lasted, were never wholly absent. In June, July and August, 1911, seizures threatening life occurred. Afterwards they altered character and never again appeared in their severe and dangerous form.

Owing to pain in either arm produced by inflation of the cuff of the hæmomanometer, estimation of blood pressure was temporarily abandoned. Distress produced by pressure on

the arms calls for some note. Pain begins when readings rise to 100 mm. hydrarg., that is before occlusion of the artery occurs. It shoots upwards, establishes itself for a few seconds in axillary structures, and then skipping over the thorax without impinging upon its parts, gains foothold in upper brachial regions on the opposite side.

Selected cases
of angina
pectoris.

In forearm and hand below the level of the cuff, numbness and intensive tingling sensations, which heighten in degree after pressure is relaxed, appear. These sensations are said to be almost unbearable, and for a few seconds after removal of the cuff they are still less tolerable than before. The dorsal recumbent pose is maintained at night, because lying on one side or the other gives pain. Soon after the patient does perchance turn on either side, pressure from the weight of the body excites pain; sometimes affecting the arm pressed upon, sometimes both arms, and on occasion, that arm alone upon which no weight is made to bear.

For many months before angina pectoris declared itself, tenderness in the palms of the hands under deep pressure was felt. A firm grasp upon the handles of the bicycle caused so much tenderness and discomfort, that cycling, an exercise to which the patient was attached, had to be given up. At this period dead fingers and numbness of the finger tips were not uncommon symptoms, troubling the patient when engaged in needlework. Inability to retain the needle between thumb and finger caused sewing to be put aside. Coins could not be securely handled except the eyes were fixed steadfastly upon them. If for one second attention were diverted into another channel, sixpenny pieces, half-pence and pence alike slipped from her grasp. Epi-critical faculty of integuments of great toes and adjoining surfaces was lost.

Selected cases
of angina
pectoris.

At that stage of the illness, when seizures began to wane, tenderness remained still in evidence, but in a lesser degree. Now thoughts of the patient were fixed on tender spots on the left thoracic wall. To one of these she frequently drew my attention. It was located just over the space where pulsation of the heart was most plainly in evidence. But until attention was drawn to the fact she had not noticed that in precisely the same situation on the opposite side of the chest wall, tenderness on pressure could be elicited.

Adenoid lumps were found at upper and outer sections of the mammæ. These seldom totally disappeared. They grew large at seasons of frequency of attack, at which times, pressure over them elicited pain. Nevertheless, they themselves were painless, for tender neurons lay not in them, but in intercostal spaces beneath. Increased frequency of attack was a common experience at menstrual periods, and at these times, fourth, fifth and sixth intercostals were excessively tender. This group of nerves innervate mammary glands. At their root in the cord they are in touch with uterine structures, through great splanchnic strands, and thence through semi-lunar, hypo-gastric and pelvic plexuses. Anatomical relations through splanchnic strands between uterus and fourth, fifth and sixth segments of the cord, and neurosis of segmentary centres of these nerves through uterine disorders explain the frequent appearance of angina pectoris among hysterical subjects.

The patient was spare of adipose tissue, and when her head was averted, structures beneath the skin in posterior

cervical triangles came into prominence. Pressure over lower strands of brachial plexuses caused pain. Upper strands were occasionally tender, but not frequently so. The right plexus was as often affected as the left. In certain instances, after seizures, during which pain had attacked alveolar regions, pressure on molar teeth gave pain in sufficient degree to prevent mastication of solid food. In two instances, after a centralised shaft of pain had glanced upward as high as the septum nasi, pressure upon incisor teeth at the upper jaw caused much discomfort.

Selected cases of angina pectoris.

During seasons of frequency and severity of seizures, firm pressure on the abdominal wall caused pain to shoot into deep regions of the thoracic cavity. This was chiefly so when pressure was exercised over epigastric and hypo-chondriac regions. Tenderness on pressure was felt in structures at the arch of the ribs, especially over the right hypo-chondrium.

It has already been remarked that hyper-plasia occurred in mammary glands at a time when nerves which supply mammæ were hyper-algesic. Phenomena of the same character were noticed at other parts. At periods of the illness, when strands of brachial plexuses exhibited intensive tenderness, joints of fingers were stiff and swollen, and contemporaneously with decline of tenderness at brachial plexuses swelling at joints abated.

During a period of great tenderness at points of outcrop of intercostal nerves, fluid gathered in right and left pleural sacs and friction sounds were heard.

Anæsthetic patches of integument cold to touch were noticed on the buttocks and over the distributary areas of external cutaneous nerves at lower thirds of the thigh, which tingled painfully under superficial friction. Great toes, while

Selected cases of angina pectoris. still retaining their normal temperature, felt cold to the patient. After the morning bath, great toes were drawn towards the medial axial line by spasms occurring in the adductors.

During months before the incidence of the first seizure, at intervals between seizures, and for a considerable time after the last attack had occurred, that is to say, during the entire continuance of the anginous habit, tender spots were never wholly absent from regions of intercostal innervation.

In estimating the order of frequency in which distributary areas of intercostal and brachial nerves were seats of tenderness, it must be remembered that usually many areas are affected at the same time, so the sum of the figures relating to separate areas largely exceeds the total number of observations. In three hundred and thirty-seven observations brachial plexuses or brachial nerves were found hyper-algesic on one hundred and twenty occasions. On thirty-five occasions nerves on the right side were alone involved. On sixty-two those on the left side. Second, third, and fourth, left intercostal nerves or one of them, was affected at two hundred and eighty-four observations. At two hundred and twenty the same nerves at the right side were tender; fifth and sixth left intercostals responded one hundred and sixty-three times, while corresponding nerves on the right side answered to pressure only sixty-one times. Whereas seventh and eighth intercostal nerves distributed to the right limb of the costal arch and the hypochondriac region below were hyper-algesic on one hundred and ninety occasions. Corresponding areas on the left side reacting on six occasions only. Fifty five times tenderness manifested itself over spinous processes of upper dorsal or lower cervical vertebræ.

In contrast with this case was that of Mr. S., a subject of angina abdominis, who manifested two tender spots only, one at the sixth dorsal spine, and the other at the epigastrium. Here intensivity made up for extensivity, for he shrieked aloud when I came upon the spot at the back. This man, who showed no very ominous features, died in a seizure shortly after these observations were made.

Dr. X. does not manifest prominent algesic signs at thoracic walls. On a few occasions only, at distant intervals, has tenderness in these regions been felt. But deep pressure

of palmar tissues induces pain. Pressure from the inflated cuff of the hæmomanometer causes pain to appear in the shoulder on the same side, and sometimes also in the shoulder and arm of the opposite side. Selected cases of angina pectoris.

When an arm is overlaid during sleep, Dr. X. is awakened by discomfort or pain, sometimes in the arm overlaid, sometimes in the other arm, and sometimes in the chest. These attacks are frequent after a good night's rest, appearing at five or six o'clock in the morning. Pain in the arm overlaid sometimes strikes into the little finger and into the palmar pad of muscle at its base. Whereas, pain in the opposite arm, chooses as its terminal the thumb, index, and middle fingers. A few minutes after pressure is withdrawn, pain ceases. When pain lingers, its departure is expedited by change of position, swinging the arms, or walking across the room.

When this patient is first roused from sleep, he hears the pulsation of his own heart and detects irregularities of rhythm which are apparently of the extra systolic type. Alteration of position, output of muscular effort, or taking a drink of cold water, is effective in restoring normal rhythm, and rendering the sense of hearing less receptive of cardiac sounds. On these occasions eructation throws large volumes of gas from the chest, and contemporaneously with its expulsion discomfort, pain, and aural phenomena depart. Probably aural phenomena are caused by hypertonus of gastric muscle, and reflex spasmodic contraction of tensor tympani.

In September, 1918, Dr. X. was awakened from sleep frequently by pain in the right shoulder, springing from a localised point corresponding with the insertion of the deltoid into the humerus. Pain in this spot was attended by numbness of little and ring fingers. Although he lay all night long on the right side, sleep was not disturbed by pain until five or six o'clock a.m. and always about the same hours. Relief came when he turned over on the other side. But it did not last long, for after the lapse of half-an-hour or so, pain in the

Selected cases
of angina
pectoris.

corresponding region was felt in the arm now overlaid. Pressure was the cause of pain, for it did not appear when Dr. X. maintained a dorsal pose.

The trend of a round of visits often directed my steps to the house of Miss A., just after Miss F. had been a subject of examination. Similitude between algescic symptoms of the one and the other is remarkable. Thoracic symptoms are the same. Points of outcrop of cutaneous branches of intercostal nerves are seats of tenderness in one case as in the other. The manner of manifestation of algesia is the same. Tender spots appear either with or without relationship with seizures. They do not exhibit constancy or lasting power, for they rise into prominence, fall out of notice, and reassert themselves within the course of few hours. Having reference to their incidence the same order of frequency prevails in the case of Miss A. as in that of Miss F. In both cases adjustment of the cuff of the haemomanometer and its inflation is followed by precisely the same symptoms. Overlying the arm is followed by the same consequences, and relief is obtained in both cases and in the same manner as it is obtained in the case of Dr. X. In the case of Miss A., arrhythmia belong to two types, extra systolic and auricular fibrillation. An interesting fact was noticed in this case. After the removal of a new growth from the obstructed descending colon, anginal cardiac and algescic symptoms disappeared and two years afterwards they had not returned.

Miss G., aged thirty-four, a subject of viscerop-tosis, suffered from anginous attacks which awoke her from sleep, also from attacks of a similar character after walking upstairs.

From time to time tender spots appeared at points of outcrop of second, third, fourth, fifth and sixth intercostal nerves, also over spinous processes and vertebræ. Selected cases of angina pectoris.

In most cases of angina pectoris passing under my notice the algesic symptom has been present, and in many prominent. Certain cases which I had regarded as exceptions from the rule, proved after many examinations, not real exceptions, for in them the symptom manifested itself upon occasion. When this symptom attaches itself to deep sensory structures only, it may be overlooked even after careful examination. In several cases occurring among cyclists although deep pressure in the palm of the hands elicited no pain, yet after a few miles run on a bicycle any extra pressure on the handles through tight gripping caused discomfort, and discomfort was felt when a chisel, hammer, spade or other heavy tool was handled. An illustration in Sir James Mackenzie's work on Diseases of the Heart, depicts an area of algesia in the præcordium, extending to the left axilla and arm.

On many occasions, in the case of Miss F., when slight indiscretions in diet were indulged in, I have noticed hyperæsthetic symptoms to flare up, and groups of tender spots appear in distributary areas, previously free from them. Another warning symptom was noticed, namely, qualminess, and frequent expulsions of flatus from the chest. If these threatening signs were disregarded, and indulgences were persisted in, seizures invariably appeared. On the other hand, a return to restricted dietary and rest led to abatement of symptoms and immunity from attack. Ultimately this patient quite regained her former good health under a course of five drop doses of belladonna and glycerine of pepsin, taken after

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meals. Three months after the last seizure had occurred a careful examination disclosed a total absence of tender spots from the chest.

Dread of cold is a remarkable symptom present in subjects of the anginous habit. Sensations of cold are closely associated with vaso-motor innervation and hyper-irritability of vaso-motor centres. In an atmosphere which does not feel cold to persons in ordinary health the anginous subjects shows signs of surface vaso-constriction. The hands become bloodless, and veins on the dorsum shrink and occupy so small a compass that they appear as attenuated threads lying at the bottom of sulci in the integuments, which had formerly been fully occupied by convex venous trunks. The skin over the greater part of the forearms feels icy cold to the touch, and patches of coldness are found on abdominal walls and buttocks. Dead fingers and dead toes are not uncommon phenomena. These symptoms are rather aggravated than relieved by exercise.

Among subjects able to walk on level ground, although their hands may be warm when they start from home, on their return they are found to be icy cold. This symptom is accompanied by goosiness of the skin. Certain subjects, on going to bed at night, refuse to undress completely, but scramble into bed, still continuing to wear vest, drawers, and socks, worn during the day. Others sleep between blankets, out of fear of coming into contact with cold sheets. Even in summer they retain the same number of blankets on the bed as they did during winter, and even then they feel none too warm.

In affected distributary zones, integuments and deeper structures occasionally show signs of nutritive disorder. The

skin may become dry and scaly, and at times lichen and herpes appear. Joints may suffer and degenerative changes and hyper-plasius may appear in fibrous tissues which surround them. In one instance under my own notice the joints of the fingers became swollen and tender. These signs disappeared under dietetic treatment and administrations of glycerine of pepsin, or pancreatic juices. In another instance, adenoid lumps gathered in upper and outer sections of mammary glands. When the edge of the breast was raised, tender spots were found in intercostal spaces beneath them.

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CASES of angina pectoris, in which thoracic symptoms are scanty and gastric symptoms are prominent, are relegated by certain observers to a separate class, and are called false angina, pseudo angina, epigastric angina, abdominal angina, or by other qualifying or sectional term. The division is arbitrary, and not warranted by clinical observation. Sir Clifford Allbutt gives attention in his work to cases of angina abdominis. Records of cases appear in medical literature, described by Heberden, Von Dusch, Butter, Leared, Petain, Hushard, Neussner, Hasenfeld, Pal, and Muller.

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Sir Clifford reports a case seen in conjunction with Professor Bradbury. The patient, Professor X., in his sixtieth year of age, after walking upstairs in a foreign hotel, began to complain of recurring attacks of indigestion. He stated that if he could get rid of a nasty feeling of imprisoned flatus at the pit of the stomach he would soon be alright. The uneasiness, which could scarcely be called severe pain, was provoked by walking. A few days afterwards, Professor X. died in an anginous seizure.

In another case there was epigastric uneasiness and sense of distension. Attacks of pain were brought on by exertion, rising to the night stool, or contact with cold bed clothes, and were readily subdued by nitrites. Mr. A., the subject of these symptoms, died suddenly.

In Dr. Glaisher's case, the patient's earlier attacks were epigastric, afterwards they settled wholly to the breast. Dr. Johnson Smith relates a case in which attacks alternated between chest and abdomen.

Sir William Osler, in his Lamleian lectures, relates the case of a man aged fifty-nine, who had typical attacks, as well as attacks of the epigastric form. He died in an ordinary attack. Hamilton in *Med. Comment. Edin.*, vol. 9 p. 307, has published a case of metastasis of pain from abdomen to chest. Sir Clifford Allbutt relates a case reported by Dr. Campbell Smith, of Tunbridge Wells. An elderly man, of sedentary habits, had been subject occasionally, for eight or ten years, to symptoms of doubtful interpretation, whether of dyspeptic or cardiac origin. In 1910 definite attacks of angina in the epigastrium, not radiating upwards, began. Usually there was no alteration in beat rate during seizures. Systolic pressure at rest 150mm. hydrarg. He died suddenly in a seizure.

Vaquez and Bordet describe a case of angina pectoris starting from the epigastrium and afterwards seating itself behind the sternum. Brewer describes two cases. One was a male, aged forty. "Fearful pain in ensiform cartilage, brought on and aggravated by meals or exertion, especially on ascents, compelling him to stop as if an iron fist were crushing his stomach. He is pallid and speechless at the time and anxious. One of these attacks began in the night during sleep. He was relieved by half drachm doses of diuretin."

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In the second case of Brewer the pain was below the xiphoid and epigastrium. In a man of sixty-eight years Brunton and Williams reported that the pain struck from the umbilicus to the back, and thence to the chest. The heart, and blood vessels were normal.

Precisely similar symptoms were observed by me in a case under Sir James Mackenzie, in the wards of Mount Vernon Hospital, Hampstead. The man was a coal porter and the first anginous seizure came on while he was shooting a sack of coal. A tender spot over the sixth dorsal spinous process was noticed during examination. Rectus abdominis muscles were rigid and prominent showing a deep sulcus between them. A blood test showed positive specific reaction. Pressure exercised over the epigastrium started a seizure, and the same phenomenon occurred when continued pressure was exercised over the tender spinous process. Pulse showed no alterations in jugular and radial curves during seizures. Walking across the ward brought on a seizure, and a seizure came on when he lay flat on his back in bed. A pose of body in which recti abdominis muscles were relaxed gave most ease. So when attacks began, he got up out of his bed and leaned over the back rail of a chair.

The gassy stomach was a prominent symptom. I examined the belly on many occasions and on all gastric resonance was found as high as the fifth rib. In him I noticed a symptom which I had previously observed in many cases. When the seizure was subsiding a continuous bubbling stream could be heard passing beneath the chest piece of the stethoscope placed over the left hypo-chondrium. The patient informed me that he was conscious of a sensation of a passing current of gas in this situation, and that the sensation was invariably felt in the same region after seizures, and at times it heralded the cessation of seizures. On certain of these occasions borborygmal sounds were sufficiently loud to attract attention of persons at other parts of the ward.

One day after hurriedly drinking a pint of hot tea and while walking, tray in hand, across the ward, he fell down and died in a seizure. At the post-mortem examination, apparently the heart only received attention from the pathologist. There was coronary disease and microscopical examination showed that the myocardium was not sound. During early seizures pains were said to be retro-sternal, but attacks observed by me while the patient was in hospital were wholly abdominal.

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Dr. William Russell, in a paper read before the Medico-Chirurgical Society of Edinburgh, in 1905, reports four cases of angina pectoris in which seizures were associated with gastric disorders.

In case one, attacks were brought on by taking nourishment, the presence of flatulence, slight excitement, and changing positions in bed. An attack has been brought on during examination of the patient by gentle pressure exerted over the epigastrium. "The point of the history which was most uncommon," says Dr. Russell, "was the fact that the taking of nourishment was almost always followed by an attack." Here my experience differs from that of Dr. Russell. Association between nourishment taking and seizures in my practice is common enough.

Attacks in Dr. Russell's case were lessened in frequency and severity by reducing the dietary of the patient to peptonized milk food. After a regulated dietary of many weeks duration, seizures ceased, and remained in abeyance for six months. Subsequently they recurred, and the patient was killed by the last of them.

In case two, serious attacks occurring after the mid-day meal, the heaviest in the day, are described. Attacks ceased, not to recur again after regulation of the dietary. No drugs were given. Case three also shows a great improvement and lasting benefit secured by a well regulated dietary. In case four, as in case one, even slight pressure over the epigastrium excited seizures. The patient suffered from pain in the epigastrium which came on in paroxysms attended by indigestion and cardiac disorder. During seizures the radial artery became markedly constricted and hardened.

Aitkin, in *Journal American Med. Assoc.* gives a case in which oppression and a little pain under the ensiform appendage was felt on walking after full meals. He would wait and belch and then go forward. At a later date angina supervened.

Cases of angina abdominis were communicated by me to the *Lancet*, May 18th and June 8th, 1912.

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Early in 1912, Mr. J. came to me with symptoms as follows:—Pain came on in the epigastric region when he walked, and particularly when he walked soon after eating. It grew unbearable when he continued to walk, but subsided when he rested. After walking was resumed and when eighty to one hundred paces had been taken pain again returned. The pain was described as beginning in the middle line just below the ensiform appendage and as radiating to the right and left from this point. As far as I could ascertain it never rose above the level of the sixth rib. It was burning and crushing in character, and was generally accompanied by flatus and a sensation of nausea. I prescribed nitroglycerine, and when he came again he told me that the tablets had always given him instant relief.

A few weeks afterwards I was asked to see him at his own house. That morning he had been awakened from sleep with pain felt in the region of the sternal synchondrosis extending over the anterior aspect of the chest wall from side to side and down both arms. The attack was accompanied by "thumping" of the heart, and lasted about five minutes. I observed a patch of algesia in the sixth left intercostal space, but none elsewhere.

The next day I passed an œsophageal tube and washed out the stomach with a solution of bicarbonate of soda—half an ounce to the pint.—A meat diet with green vegetables was recommended and abstension from sugars and starches. Since then the patient has had no bad symptoms, and now feels pain only occasionally on walking.

I suggest that the symptoms during the early attacks resulted from tetany of gastric muscle—that is to say, from gastrismus—and during the latter and more severe seizures from gastro-œsophagismus, and that the beneficial effects

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derived from the administration of nitroglycerine were occasioned by the action of this drug upon gastro-œsophageal muscle. The systolic blood pressure was 140 mm. hydrarg. cardiac sounds normal, radial and jugular tracings normal, no albumin.*

Since I had seen him, he had left London and was living near the sea. He had not again suffered from a severe attack of angina, and often he had taken long walks and spent fatiguing days without complaining of a symptom. War diet told upon him. He had complained many times of the difficulty of digesting the diet offered to him. On the day of his death, caught in a shower of rain, he hurried home from his walk, sat down before the fire and was found dead a few minutes afterwards.

Four cases of angina abdominis† have recently come under my notice:—Case A, pain in epigastrium, excited by walking; Case B, pain in epigastrium, left shoulder and arm, excited by walking; Case C, pain in epigastrium, both shoulders and arms, excited by walking; Case D, pain in epigastrium, excited by walking. This patient at times has suffered from severe attacks of angina pectoris, in which pain was limited to the upper parts of the chest, the neck, and the arms. In Cases A, B, C, and D there is no sign of organic disease.

In these cases there is one symptom in common—namely, pain in the epigastric region, and in all, pain is associated with algesia. In Cases A, B, and D the seat of algesia is the rectus muscle. The integuments over the muscle may be gently pinched without causing pain. In Case

*Reprint from the *Lancet*, May 10th, 1912.

Reprinted from the *Lancet*, June 8th, 1912.

C the integuments are alone affected. In Case D a segment of the rectus muscle is sometimes found raised and hard upon palpation suggestive of the presence of an abdominal growth. In A, B, C, and D pain appears, and the algesic patch is found in the areas of distribution of the eighth and ninth intercostal nerves. I do not think anyone will be found to dispute the suggestion that pain in angina abdominis belongs to the referred type, and that impressions which excite it are of visceral origin. Nor will those who have adopted the new views on pain expounded by James Mackenzie, Head, Ross, Bertrand Dawson, and Hertz take exception to the inference that referred pain appearing in the distributory area of the eighth and ninth intercostal nerves is the result of hypertonus of gastric muscle. So far, then, we are on solid ground—namely, it can be contended that the epigastric pain in angina abdominis results from hypertonus of gastric muscle. It may also further be inferred that muscle undergoing hypertension is situated in the middle third of the gastric wall and in the pyloric vestibule.

In regard to Cases A and D, here the matter ends and there is no more to be said. In reference to Cases B and C, pain appears simultaneously in the epigastrium and in the arm. Since in these cases the epigastric and brachial phenomena always appear together and disappear at the same instant, they must be excited by a single agency, and if the epigastric symptom is induced by hypertension of gastric muscle the humeral and brachial pain must owe its origin to the same or an allied cause. It is necessary now to explain how hypertension of gastric muscle induces pain in the shoulder and arm.

In Case B pain occurs at the acromial region, at the back and inner side of the triceps muscle, at the groove on the posterior aspect of the inner condyle, at the inner border of the ulnar bone and at the dorsum of the hand, involving the

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ring and little fingers. This description of the region of pain incidence also serves in the case of C. It is obvious in these cases that humeral and brachial pain occurs in the distributory areas of the spinal accessory, the musculo-spiral and the ulnar nerves.

These nerves are rooted in lower cervical segments of the cord, which are in afferent connexion with œsophagus.

We must now consider how afferent impressions generated by hypertension or tetany of gastric muscle pass simultaneously from gastric muscle to the eighth and ninth segments of the thoracic cord, and also to the vagus centre. The greater number of the muscular fibres constituting the contractile coat of the stomach receive motor energy from the vagi; the rest from the eighth and ninth segments of the thoracic cord. In the pyloric vestibule strands of fibres receiving motor innervation from these sources are mixed. Since visceral muscle is innervated from both members of the autonomic group—the one supplying motor energy, the other inhibitory—the afferent nerves of gastric muscle must in part be directed to the medulla, and in part to the segments of the thoracic cord; consequently, it follows that pain impressions, generated by hypertension or tetany of gastric muscle reach both the vagus centres in the medulla and the segmentary centres of the thoracic cord. This argument is particularly applicable when hypertonus is occurring in the pyloric vestibule where strands of muscle of converse innervation are mixed.

In Case B a phenomenon occurs during the seizure which confirms the views herein expressed of the implication of the vagus centre. At the time of pain incidence, a quantity of saliva, estimated at a cupful, fills the mouth and pours out in a stream; it is neither retched up nor coughed up, but, as the

¹ Cunningham's Anatomy, p. 516.

² Ibid., p. 518, Fig. 417.

patient expressed it, "comes into his mouth on its own." It is evidently submaxillary glandular secretion, as when I examined his mouth during a seizure saliva was pouring freely from Wharton's duct. The chorda tympani, which, when stimulated, causes a flow of submaxillary secretion, is derived from the portio intermedia or the seventh cranial nerve, and the portio intermedia has its deep roots in connexion with the glosso-vagus accessory nuclei; consequently hypertension of gastric muscle induces a reflex which acts through the vagus centre upon the great salivary glands, causing a free flow of saliva. This reflex is brought into play in the prodromal stage of vomiting when salivary phenomena are frequent.

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When an individual is predisposed to angina abdominis through increased irritability of medullary and spinal centres, an attack may be induced by any agency causing an increase in intra-gastric pressure. Hertz has shown that an increase in intra-gastric pressure of 12 to 14 mm. hydrarg. induces hypertonus of gastric muscle. On the other hand, pain subsides when intra-gastric pressure falls. Deflation of the stomach by eructation of flatus or by means of an œsophageal tube brings the seizure to an end. Nitro-glycerine, by lowering the tonus of gastric muscle has a similar effect.

In these cases nothing abnormal was noticed as occurring in connection with the action of the heart.

There is no possible doubt as to the existence of the gastric factor in the angina pectoris syndrome. It is referred to by many writers. Heberden in his favourite description of the disease speaks of it: "Those who are affected with it (angina) are seized while they are walking, and more particularly when they walk soon after eating." James Mackenzie, who has given much attention to the nature of the paroxysm, mentions the frequent association of flatus with the pain symptom, and suggests that air is swallowed by the patient in

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the initiatory stages and eructated in the later. He writes: "Another symptom is very common in these cases—namely, the belching of air."³ In another place: "The chief feature is the noisy exposure of air from the stomach,"⁴ and again: "The case may end by expulsion of air from the chest."⁵ Douglas Powell observes: "Eructation gives relief."⁶ "The patient vomits and becomes easier."⁷ "Flatulent distension of the stomach is frequently an exciting cause."⁸ "Flatulent distension is a frequent concomitant of anginal paroxysms."⁹ "Dyspepsia is a frequent exciting cause."¹⁰ R. Quain has noticed this symptom: "An oppressive meal of indigestible food brought on a first and distressing anginal attack followed by others."¹¹ It passes off with the escape of flatulent air from the stomach.¹² Stomach often affected, giving rise to eructations and vomiting.¹³ Exciting cause, overloading the stomach.¹⁴ Attack may terminate with vomiting or with eructations.¹⁵ This phase of the subject has also received attention in the works of Russell and Gibson.

A patient under my own care, namely, Dr. X., on setting out for a walk seldom covers a distance of eighty yards without feeling thoracic pains and eructating flatus. If eructations are copious Dr. X. is able to continue walking for miles without suffering any further attacks, but sometimes several recurrences of pain associated with expulsions of gas take place before a period of immunity is attained.

In the case of three patients, eructations of flatus do not occur, but if the stethoscope be applied to the left hypochondrium in the neighbourhood of the duodeno-jejunal

³ Diseases of the Heart.

⁴ Ibid.

⁵ Ibid.

⁶ Allbutt's System, vol. vi.

⁷ Ibid.

⁸ Ibid.

⁹ Ibid.

¹⁰ Ibid.

¹¹ Dictionary of Medicine, p. 53.

¹² Handbook of Medical Science, Buck, p. 227.

¹³ Ibid.

¹⁴ Medical Diagnosis, Stevens, p. 705.

¹⁵ Ibid.

flexure at the moment when the seizure is undergoing subsidence borborygmal sounds are usually heard, and sometimes the sound of rushing gas continues for several minutes afterwards. In the case of another patient, after the administration of nitro-glycerine, the same phenomenon was noticed. I have verified this sequence of events on many occasions. In one case, no very definite flatulent symptom was noticed, but heart-burn, nausea, and an uncomfortable sense of fulness were frequent accompaniments of the seizure. From these remarks it is observed that gastric symptoms occupy an important and probably a constant place in the anginal syndrome.

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Fulness of the stomach, whether occasioned by the presence of an excess of solids, fluids, or gases, seems to have no effect by itself in exciting a seizure. Dr. X., in a series of experimental observations made just after a full meal, noticed that although sometimes the waistcoat had to be unbuttoned on account of distension of the abdomen, no symptoms occurred while he yet sat at table, but immediately after he got up and began to walk thoracic pain appeared, and the same result was noticed on several occasions when he stooped to pick up something from the floor and when pressure was otherwise brought to bear upon the gastric wall. Moreover, cardiac action remained normal as long as an attitude of rest was maintained, but as soon as exercise was begun and pain was felt the action of the heart became disturbed. Exercise, however, does not stand alone as the exciting cause of an attack. On one occasion it was induced by a heated discussion, on another by a draught of cold water, and on yet a third by a few sips of hot coffee.

There can be no doubt that although fulness of the stomach does not by itself excite an attack in persons predisposed to angina, yet it heightens the tendency to an attack. Before breakfast, when presumably the stomach is empty,

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paroxysms do not occur as soon during a walk as they do at other parts of the day. They are not as frequent when the dietary consists of meat as when it is made up of mixed foods among which sweets and starches occupy a prominent place. They occur less often and are not severe when gas is poured freely from the chest. After gastric lavage has been practised I have known patients walk many miles without pain, although for weeks before insignificant efforts had usually resulted in seizures, and when large doses of iodide of potassium are administered, which maintain an atmosphere of iodine in the stomach and intestines and thus prevent fermentation and voluminous accumulation of gas,¹⁶ attacks of pain may cease altogether.

When exercise is taken by the healthy subject upon a full stomach, by the flatulent dyspeptic, or by the subject of angina, certain symptoms common to all occur. A sensation of fulness is felt in the epigastrium and a desire to eructate flatus is experienced. According to Hertz precisely similar symptoms are felt when intra-gastric pressure is raised by the induction of hypertonus of gastric muscle,¹⁷ consequently it may be inferred that muscular effort induces hypertonus of gastric muscle, and that hypertonus is the cause of the gastric symptoms which make their appearance in the anginal subject when he walks soon after eating. That a full stomach predisposes to hypertonus is abundantly demonstrated by Hertz,¹⁸ and hypertonus, whether excited by walking, by mental excitement, by sensory impressions, or by intra-gastric stimuli, may be regarded as inducing the gastric symptoms contained in the anginal syndrome.

The effects of hypertonus of gastro-œsophageal muscle upon the central and peripheral circulatory systems are

¹⁶ During a course of treatment when Dr. X was taking 40 grains of iodide of potassium daily he lost 5 inches in abdominal girth.

¹⁷ Hertz: Goulstonian Lectures.

¹⁸ Ibid

illustrated in cases of gastrismus and œsophagismus.¹⁹ The cardiac and circulatory symptoms associated with the prodromal stage of the simple vomiting attack demonstrate the profound impression produced by hypertonus of gastric muscle upon the heart and vessels through the central nervous system, and the progressive weakening of the contractile function of the myocardium by a prolonged season of paroxysms of œsophagismus is a matter to which references have been made and may be found sparingly in the literature of medicine.²⁰ The effect of gastro-œsophageal hypertonus upon the circulatory system is illustrated in a case described by Dr. William Russell, Royal Infirmary, Edinburgh, referring to which the following sentences occur :—

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The sensations which now more ordinarily precede an anginal attack were a sense of discomfort and distension in the stomach and attacks were often associated with definite flatulent distension, the escape of gas being followed by relief. The medical attendant noted that when the abdominal discomfort supervened the pulse-rate increased and there was distinct hypertonus, as the attack passed the vessel wall relaxed and the rate returned to normal.

In the same case it was noted "that any digestive upset at once threatened to produce an increased number of attacks."

In short, in accordance with the preceding argument the anginal habit, whether of the abdominal or thoracic type, results from a state of increased irritability of certain medullary and spinal centres, and the paroxysm is excited by impressions reaching these centres from gastro-œsophageal muscle when in a state of hypertonus or tetany.

In reference to these cases, Sir Clifford Allbutt in a private letter says :—"I was much surprised to see leaders of the profession speaking of abdominal angina as a new observation. It has been familiar enough to me for many years.

¹⁹ Gastrismus, Twentieth Cent. Med. vol. x., pp. 539-540.

²⁰ Œsophagismus, T. M. Tibbetts, Practitioner, August, 1911, p. 237.

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You have done some good service by emphasising the cardiac end of the stomach as a very sensitive vagus area. This part of the stomach is a most important one, and you have illustrated this truth. By this viscus a decayed heart may be nipped out without angina, or with angina if aortic disease be also present. Your cases fall in with some experiments Wenkeback has been making by compression of vagus in neck. He finds this nerve markedly more sensitive in angina pectoris.

"Angina pectoris is common among us if we are on the look out for the milder forms of it. In walking up the smallest incline the anginal patient will shy, and stop to look in to a window. In a few seconds the pain will have vanished, with nearly always an eructation of wind, and be regarded as a simple indigestion. The instancy of the arrest surprises the man. A moment and it is gone; but it comes again and again, and leaves upon him the same uncanny spell, so he goes to his physician just to be assured that it is nothing, nothing but a touch of flatulence to which he is subject as his father was before him."—Sir James Goodhart, *Lancet*, July 1st, 1905.

It was a saying of Sir William Broadbent, "When a patient comes complaining of heart trouble, I never omit to carefully examine the stomach." There is good reason for the adoption of this course, because the heart is extremely sensitive to disturbances occurring in the gastric wall. When the wall of the stomach exposed during abdominal section is tapped with the handle of a scalpel, a localized spasm occurs at the point struck, and immediately afterwards the heart responds and ceases to beat. In certain anginous subjects when pressure even of a moderate character is exercised over the

epigastrium, inhibitory phenomena occur. In the case of the frog a tap on the abdominal wall causes inhibition. Fainting or sudden death has not infrequently followed a blow in the epigastrium. Every writer mentions gastric disorder as a prolific cause of palpitation, and the extra systolic trope is a usual attendant of gastric trouble. Out of thirty cases of gastric disorder occurring consecutively in the ordinary course of my daily practice, in twenty-seven I noticed this particular form of arrhythmia. Yet in these cases no suspicion could be entertained of cardiac mischief. This trope can be experimentally induced by administration of large doses of digitalis, which has the reputation of causing vagal hyper-irritability. The extra systolic figure is the most frequent type of arrhythmia noticed in persons who are subjects of anginous seizures.

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Walter Broadbent relates a case of nodal rhythm in the case of a lady who at times suffered from a distended stomach. Whenever she feels an attack of paroxysmal tachycardia coming on, she can almost invariably quickly stop it by a mixture containing liquor pepsine cum bismuth and nuxvomica. Normally her gastric resonance does not rise above the seventh rib, but when seen during an attack it is invariably up to the fifth rib.

Dr. Walter Broadbent relates also notes of the case of an elderly gentleman who passed through an attack of bronchitis without manifesting the slightest irregularity of his pulse or any symptom of heart trouble, but a few months later, after imprudent dinner, suffered from indigestion which, although only giving rise to slight nausea, caused very marked giddiness.

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His pulse was quite irregular. On listening to his heart, there were frequent extra systoles, gastric resonance was found to be as high as the fifth space. In about a week on simple diet and with medicine directed solely to the gastric condition, the pulse steadied down to become quite regular again. The giddiness disappeared, and the gastric resonance subsided to the seventh rib level. Notes of another case are related by the same observer.

A middle aged lady with a thick walled high tension pulse had for some months been subject to suffocative feelings in the chest, coming on generally about an hour after meals. Then pain took the place of these feelings and spread to the left arm. The attacks became more frequent, occurring five or six times a day and once or twice in the night and had no relation to exercise.

On examining the heart the apex beat was an inch outside the nipple line, but was forcible and the sounds were good. The aortic sound was attenuated. There was no complaint of indigestion, but the stomach was very tympanitic, and resonant up to the fifth rib. Dieting, alkalines, carminatives and blue pill, unexpectedly produced no improvement, trinitrin gave a little relief, but not much. She was then put on milk and junket only, and all medicines were stopped. Six hours after commencing the milk diet attacks of pain ceased and never recurred. After a week she was allowed bread and milk and was gradually got on to ordinary diet.

Pseudo angina, to which this case was attributed by Dr. Broadbent is in reality true angina; indeed, Dr. Broadbent admits that distension of the stomach has the same effect in true angina as in that called by the hyphenated name. For he proceeds to say, "Flatulent distension of the stomach may bring on attacks of true angina. A man walked to my out

patient department, a few years ago, complaining of attacks of pain in the chest. He had aortic regurgitation and I noticed very high gastric resonance. He was sent up to the ward for admission. While getting ready for bed, he suddenly clutched his chest, and before anything could be done, fell back dead. At the autopsy the heart did not suggest that it had come to the end of its tether, and the pressure upwards by the stomach was probably the real cause of death.—Lancet, October 4th, 1913.

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Sir William Broadbent relates the case of a patient with mitral stenosis and regurgitation, who after a hearty breakfast in bed, leant forward over a basin to wash his face, and died suddenly. In this case it is reasonable to assume that by leaning forward and flexing the upper part of the trunk upon the lower, the inflated rotund organ was flattened against the diaphragm, its containing capacity was lowered and intragastric pressure was increased. According to Dr. Hertz's experiments recited in his Goulstonian lecture, when intragastric pressure is raised above 12 to 14 mm. hydrarg. hypertonus of the gastric wall is induced and symptoms are felt.

The following case appeared in the Lancet, July 6th, 1912. It was communicated by Dr. Walter K. Hunter, Physician to the Royal Glasgow Infirmary.

The patient, aged fifty-six, was in my wards of the Glasgow Royal Infirmary from September 6th, till the time of his death on October 7th, 1911. He first noticed the pain, which was situated in the epigastrium, about eighteen months before coming to hospital. The pain at first was dull and aching in character, usually coming on about an hour after food and most often relieved by the taking of food. It was frequently associated with some flatulence, but there was no vomiting. Shortly before admission the pain had altered its characters, being now sharp and shooting, and coming on in a series of very frequent paroxysms which had no relationship to the taking of food. The patient had been gradually getting thinner, having lost over a stone in weight in the previous twelve months. For eighteen months there had been slight jaundice, but there was no history of alcoholism or of syphilis. The patient's previous health had always been good. His mother was alive and well: his father had died suddenly from a "shock." Six brothers and sisters were alive and well.

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On examination the patient was seen to lie in bed in the semi-recumbent position. He was very restless, and there was a good deal of dyspnoea, the breathing being at times of the Cheyne-Stokes character. There was a slight jaundice tint of the skin and conjunctive. The pain in the epigastrium was more or less constant, and there were frequent and severe exacerbations, each paroxysm lasting about one minute. During the spasms of pain the respirations became quickened and the face rather cyanosed. The cardiac area was not increased in extent, though there seemed to be some slight increase in the manubrial dullness. The cardiac rhythm showed considerable irregularity, and the type of arrhythmia seemed to vary from time to time. Sometimes it was trigeminal, at other times there would be a systole entirely left out, and as a rule the various systoles seemed to differ a good deal in length. The heart sounds both at the apex and at the base were indistinct and of poor quality; there was, however, no murmur to be heard.

During the month the patient was under observation he had paroxysms of pain nearly every day. The pain was always referred to the epigastrium, and the paroxysms would come on about every fifteen to twenty minutes and last about one minute. This would go on for an hour or a hour and a half at a time. The paroxysms of pain were very severe, and at one time it was thought that the patient was suffering from hepatic colic. He often complained of a feeling of sickness, but he never vomited more than a very few ounces of a greenish-looking fluid.

The possibility of its being a case of angina abdominis was considered and the blood pressure was taken on several occasions during the paroxysms of pain as well as in the intervals in between, but the pressure was unaffected by the pain. During the time the patient was in hospital the systolic blood pressure ranged from 150 to 155 mm. hydrarg., except for a day or two just before death, when it fell to 115 mm. hydrarg.

At the post-mortem examination the walls of the heart were found diseased. There was hypertrophy as well as dilatation. In the aorta there was a wide spread, patchy atheroma. Coronary arteries also presented a patchy atheroma with calcification.

The stomach was greatly congested and scattered over the surface were a considerable number of small hæmorrhagic ulcers, as well as some flat cicatrices of a similar size. The hæmorrhages each measured about one-eighth to a quarter of an inch in diameter.

Dr. Johnson, of Brixton, sent me the report of a case seen by him a few days previously. Mrs. T., aged sixty-three years. Heart sounds somewhat distant. Slapping first sound

at apex, otherwise no evidence of valvular disease. Pulse 110. Was called to see her at eleven p.m. Pain in region of heart and left shoulder. Attack had come suddenly, she felt she could not breathe and was dying, pain was then passing off. Inhalation of nitrite amyl administered with very good effect. Abdominal examination revealed inflated bowels, very tympanitic. Patient states that lobster salad had been taken at luncheon, and had given her "wind." Patient gave a history of previous attacks. Dr. Johnson formed the opinion that the attack was one of angina pectoris, brought on through indiscretion in diet.

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In the case of Mr. M., who at last died from an anginous seizure, I had opportunity of noticing the evolution of the painful attack from a painless form of syndrome. When he first consulted me he was a hale and hearty man, manifesting no mark of organic disease. Things which troubled him only were chronic constipation and a gassy stomach, otherwise, for so he told me, he felt well and fit. Both symptoms were relieved under a course of treatment, but, as I had reason to know, they recurred again and again. I visited him many times during the next four or five years, and always, on account of these troublesome disorders.

He explained that while he sat at table after a meal, the only sign of gastric disorder was a feeling of tightness about the chest, which was at once relieved by loosening waistcoat and trouser band, but when he walked soon after eating, or went upstairs, the sense of fulness increased, and, on many occasions, fulness was attended by palpitation or by feelings of nausea or faintness. In consequence of these sensations he was uneasy about the condition of his heart, and for his own satisfaction, I examined his chest many times and always with the same result. The heart presented no mark of disease.

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One day, at about one hour after dinner, when walking uphill, the sense of fulness at the chest, merged into pain. Pain now felt for the first time began at a point about two inches below the left nipple, extended upwards and outwards, skirted the mammary elevation and terminated in the region of the upper intercostal spaces, not far from the sternal border. Being nervous on account of the advent of this new symptom, he stayed at home next morning from business, and asked me to visit him. The examination then made differed from former ones, not on account of the condition of the heart, which remained normal, but on account of the state of the thoracic wall, which presented, for the first time, several tender spots at points of outcrop of intercostal nerves. Tenderness was felt in both sides of the thoracic wall, but it was more intensive on the left than on the right. This finding, in conjunction with the history, made plain the nature of the complaint. From that day to the day of his death seven years later, pain recurred whensoever he walked uphill, upstairs or far afield, and particularly when this exercise was taken soon after eating, but no sign of cardiac disease ever became manifest. He died in a characteristic seizure of angina pectoris which had lasted for more than two hours.

This case is interesting as showing a causal connexion between chronic gassy stomach and the angina pectoris, and as giving an illustration of the evolutionary progression of processes of the former complaint into the latter.

The presence of "risus sardonius" removes the next case from the ordinary category of fainting attacks, and justifies the title of "angina sine dolore."

*On the morning of Saturday, May 20th last, a man, aged

sixty-three years, after taking a bath, was seized with a fainting attack and called his wife to his assistance. With her help he put on some light clothing and a dressing gown and went downstairs. While seated at table in the breakfast room, he complained of feeling ill. The fainting attack recurred and he fell into a state of semi-consciousness. When I entered the room a short time afterwards he seemed to be dying. The posture of the body indicated collapse. He had sunk into a heap in his chair. His head was resting on one of the arms, and his chin was depressed on his chest. His arms hung listlessly by his sides. His face, neck, and hands were cold, grey, bloodless, and wet with perspiration. No pulse was felt in the radial artery, and respiration had apparently ceased. But for the fact that the muscles of the face were contracted and the jaws clenched I would have come to the conclusion, as his wife had already done, that he was dead.

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The sardonic grin distorting the man's features reminded me of a similar expression of countenance often witnessed in persons during the course of an anginal seizure, and in certain cases of this disorder having noticed instant relief follow from deflation of the stomach I proceeded to pass an œsophageal tube. A gap in the wall of teeth at the molar region of the jaws furnished a ready means of access to the throat and allowed me the opportunity of performing the operation without delay. Upon the distal end of the tube engaging the lower end of the œsophagus, or entering the stomach, I do not know which, it liberated gas in considerable volume, and immediately afterwards the patient was observed to take a deep inspiration. The tube was permitted to remain *in situ* until pulse, respiration and consciousness were fully restored, and then irrigation of the stomach with hot water was practised.

The patient had recently shown signs of heart failure

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when ascending flights of stairs, when walking on hilly roads, and when engaged in other kinds of strenuous exercise. The pulse had shown signs of myocardial weakness and intermission, even at times of repose. After the seizure the pulse grew firmer than it had been for several weeks past and its rhythm was more even and without intermissions. The patient walked upstairs without the signs of distress to which he was accustomed, and on the following Monday went to town, spent many hours in his office, and attended to his business affairs after his usual custom.

The seizure in this case illustrates the operation of a gastric reflex determining heart failure and belongs to a category described by me in a paper which appeared in the *Lancet* of June 18th, 1910, entitled "A Comparison made between the Simple Gastro-circulatory Seizure and the Angina Pectoris Attack." The pathological conditions underlying this form of seizure and also that of angina pectoris consist of increased irritability of the glosso-vagus-accessory group of medullary ganglia, following in the train of a long course of gastric disturbances, hyper-tonus of gastro-mural muscle, and augmented intra-gastric pressure. The immediate cause of the seizure is inhibition of the heart through abnormal vagus stimulation.

The symptom referred to above, namely—the risus sardonius—besides being occasionally seen during the angina pectoris attack, is of exceedingly frequent occurrence in young infants. It is characteristic of flatulent distension of the stomach. It is excited by irritation of the glosso-vagus-accessory nuclei which are closely related in the medulla with

nuclei of the seventh and fifth cranial nerves, branches of which innervate the muscles of the face and lower jaw. of Selected cases of angina pectoris.

The remarkable result obtained from the passage of the œsophageal tube attracts attention to the importance of gastric symptoms in cases of this type, since many cases commonly regarded as illustrations of impairment of the contractile function of the myocardium, among which angina pectoris is usually numbered, are in reality subjects of a gastric reflex.

At my request on January 9th, 1911, Dr. Charles R. Box, pathologist of St. Thomas' Hospital, made a post mortem examination of Mr. R., aged sixty-two years, who during the latter ten weeks of his life, had suffered from seizures indistinguishable from those of angina pectoris. The following passages are extracted from the report :—

“The body was emaciated considerably, but there was a small quantity of subcutaneous and subperitoneal fat. The right pleural sac was quite healthy. . . . The left pleura was free from inflammation or effusion, but on everting the lung small nodules of white growth were seen beneath the pleura close to the lung root. . . . On slitting up the œsophagus an extensive carcinomatous ulcer was exposed. The upper margin of the growth was at the level of the bifurcation of the trachea, the lower limit was close to the cardiac orifice of the stomach.” . . .

“The pericardial sac was healthy and the heart was normal in size, all the valves were quite healthy. The coronary orifices were not diseased and sections of the arteries in various parts of the heart-wall showed no obstruction nor disease of any sort. The myocardium was rather soft but not unhealthy. The aortic arch, the thoracic aorta, and the

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upper part of the abdominal aorta were in appearance quite healthy."

Being present with Dr. Box during the examination I had observed that the lumen of the lower part of the œsophagus was abnormally large, and on receiving his report I wrote to him making enquiry upon this point. To my letter I received the following reply :—"Owing to the ulceration at the site of the growth the œsophogeal lumen was slightly enlarged."

Eight weeks before his death, namely on November 7th, 1910, I saw Mr. R. for the first time. He was said to be suffering from "windy attacks which caused pain at his chest." He had recently returned from a visit to Hastings where I understand he had been in the habit of taking long walks. During the last fortnight he had felt pain in the chest when walking up hill and even sometimes on level ground, which ceased when he halted and came on again when he had gone two hundred or three hundred paces further. The seizures came on earlier and were more painful when he walked soon after eating and they sometimes, but not always, subsided immediately after the eructation of flatus.

Moreover, similar attacks came on without any apparent cause when he was engaged in sedentary occupations and even awakened him from sleep at night. The night attacks were severe, sometimes lasting half or three quarters of an hour. He was terrorised by them and shed tears while relating the sufferings he had endured. He remembered having had attacks of flatulent distension from time to time for years, which like these were relieved by the expulsion of flatus, but never before had he suffered pain with them.

Pulse rate normal, heart sounds heathy. Systolic blood pressure 136 mm. hydrarg, no cough nor expectoration, area of gastric resonance not increased, urine highly acid, no albumin, no sugar, liver apparently normal size. No abdo-

minal tenderness. Showed signs of absence of sub-cutaneous fat. His friends stated that he had lost flesh lately, but he said he "belonged to the order of the lean kine" and had always been thin.

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Considerable tenderness was felt on pressure over the sternum extending from the synchondrosis to the ensiform cartilage. It was especially marked in the middle line of the sternum, at the region corresponding with the plane of the second and third ribs and their intercostal spaces. So tender was this area that he called out in pain when I exercised a very moderate amount of pressure on it. Pain was also felt when pressure was made over the left, second and third intercostal spaces, the painful area extending from the border of the sternum to the anterior axillary fold. This last observation was made when the patient's arm was raised above his head. Pressure was also made on the intercostal spaces on the right side, but without causing pain.

Upon my first visit I had given the patient detailed instructions to take precise note of the location of pain incidence upon the occurrence of further seizures, and on a later visit he related his experience to me and pointed out with his finger on the exposed chest wall the place of initial impact of pain, and the areas coming under painful impression during the course of the attack.

Pain had begun in the second left intercostal space near the sternal border, and the area of its incidence had grown circumferentially and extended over the left thorax. A similar area of pain incidence was soon afterwards felt in a like position on the right thoracic wall, and the two areas coalesced in the middle line. New areas of incidence then sprung into being at the upper third of the arms upon their inner aspect, although not involving the axillary fossæ. Throughout an interregnum was maintained between the pain areas of the chest and those of the arms. According to the

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patient's account the pain now became too severe to allow him to make further observations, but he added, "my chest, shoulders and neck seethed with pain, while below the belt I was quite free from it."

On one occasion only did I see Mr. R. in the throes of a seizure; he had risen in bed from the reclining to the sitting posture to more advantageously greet me as I entered his room, and the sudden alteration in position precipitated an attack. For some few minutes afterwards, while his nurse was looking for the bottle of nitro-glycerine tabloids, which had been mislaid, I had opportunities for making observations.

The skin of the face and hands and chest was cold and grey, and in some parts suffused with sweat. The radial artery was small and soft, pulse rate 120. The heart's pulsations which corresponded in rate with those of the artery, were of even rhythm, and were distinctly felt through the walls of the chest. There were intermissions at infrequent intervals. Ineffective efforts were being made by the patient to expel gastric flatus. It was evident that the attack was gastro-circulatory. Immediately after the administration of $\frac{1}{100}$ th grain of nitro-glycerine, pulse rate returned to 80 beats per minute, and attempts to eructate flatus ceased.*

After a week's rest in bed on light food and with administration of $\frac{1}{100}$ th grain nitro-glycerin, whenever occasion required, Mr. R. found himself suffering from little or no pain. Within ten or fifteen seconds after swallowing a crushed tabloid the pain of the seizure invariably subsided, and while the drug was administered regularly several times a day, painful symptoms seldom arose.

Indeed, from the day on which he swallowed the first

* The action of the nitrites is upon every kind of plain muscle throughout the body—Dixon's Pharmacology, 1908, p. 194.

tabloid, to the day of his death, on two occasions only did he suffer much pain. On one, the supply of tabloids had unexpectedly come to an end, and on the other, the bottle containing them had been mislaid.

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With relief from pain, a period of general improvement set in, giving his friends hopes of an ultimate recovery, but the lull was temporary. Dysphagia, absent at first, now became a feature, strength day by day declined, and he died suddenly on January 7th, 1911.

A remarkable feature in the history of this case of œsophageal carcinoma is the relief of pain afforded by the administration of nitro-glycerine. About its local effect upon gastro-œsophageal muscle there is no possibility of doubt. Morphia, experimentally exhibited in the course of the illness, had the effect of inducing sleep, but did not prevent a paroxysm of pain from awakening the patient from sleep, whereas nitro-glycerine, exhibited during a seizure, gave instant relief, and when taken regularly, prevented the incidence of seizures. When this fact is considered side by side with another, namely, that exhaustive eructation of flatus conferred immediate relief from pain, the inference is rational, namely, that pain, the expression of hypertonus of the muscular tunic of the gastro-œsophageal track, was excited by high intra-gastric and intra-œsophageal pressure.

Let us consider a few anatomical and physiological facts and pathological conditions, together with historical evidence, which, placed side by side, tend to throw light on the nature of the seizures experienced by Mr. R.

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A Summary of Facts and Evidence :—

1. Ulceration of the wall of the œsophagus—below the level of the bifurcation of the trachea.
2. Enlargement of the lumen of the œsophagus in this region.
3. The presence of the reticulated and cage-like expansion of the vagi nerves, known as the plexus gulæ, embracing the œsophagus in its ulcerated portion.
4. The existence in the plexus gulæ of sympathetic fibres having connexion with the roots of the second, ninth and intermediate intercostal nerves in the corresponding segments of the cord.
5. The existence of pain, during the seizures, in the area of distribution of these intercostal nerves and their extensions.
6. The existence of tenderness in distributory regions of these nerves.
7. The existence of circulatory phenomena during the course of the seizure such as those experienced in the pre-expulsatory stage of the simple vomiting attack.
8. A history of flatulent dyspepsia and consequently a history of seasonal intra-gastric pressure.
9. Relief from pain on liberation of the gastric atmosphere.
10. Relief of pain on relaxation of gastro-mural muscle through the administration of nitro-glycerine.
11. Evidence of excitement of pain by causing an increase in intra-gastric pressure, namely by walking, especially after eating.

Mr. G., aged sixty-four, enjoyed fairly good health, although for the last ten years he had been the subject of chronic dyspepsia, associated with gastric and abdominal tension and frequent flatulent attacks. Nevertheless he had engaged himself in business day after day without let or hindrance.

Recently attacks of pressure at the chest, associated with flatulence, had awakened him from sleep at night, causing him to rise up out of his bed and pace the floor of his room. After walking about for some little time, quantities of gas were thrown from his chest. Symptoms then abated, and he went back again to bed and got off to sleep.

On November 21st, Mr. G. stated to me that he had been seized with flatulent attacks on several nights in succession. Like former seizures they were associated with dyspnœa and flatulence, but unlike them, they were attended by pain.

A description of the attack occurring on the night before

my interview, is given in the patient's own words, supplemented by the testimony of his wife.

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"For several days I have been careful about my diet," he said, "and last night before going to bed I had a cupful of bread and milk for supper. A light was left burning in my room in anticipation of the occurrence of further seizures. Soon after two o'clock a.m. I was awakened from sleep, breathless and in pain. My stomach and chest were bound up tightly by cramp, and every few seconds I was convulsed with spasms which shook my frame, I felt suffocated and gasped for breath. I felt sick but could not vomit. At first pain limited itself to my stomach, but soon afterwards it extended to back, chest, neck, shoulders and arms.

"I remained in this helpless state for several minutes, fearful as to what might be the end of it. At length cramp, which was holding me in its grasp, gave way, and pain instantly ceased. At the moment of cessation of cramp and pain, but not until then, I was conscious of a turmoil between wind and water going on in my bowels, accompanied by loud rumbling, splashing and gurgling sounds, which continued for many minutes after pain had left me."

Mrs. G. said, "The attack from which my husband suffered last night differed from previous ones; several minutes before he awoke I was disturbed from sleep by a shaking motion of the bed, and then I noticed that his hands were clenched and his shoulders were jerking. The jerking stopped for a few seconds and then went on again. Again it stopped, and again it went on. He was gasping for breath. He tried to speak but his language was so broken I could not gather what he said. He was sweating heavily and his night gown was soaked through with sweat." When asked if she had noticed the abdominal gurgling sounds. "Yes," she replied, "they occurred just after the attack was over, and they were loud enough to be heard across the room."

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During the night and on the following morning, the convulsions of the muscles of the neck, shoulders, arms and legs, continued to occur at intervals, but these seizures were unattended by pain. At mid-day the patient was seen by me. He was lying upon a couch and no spasmodic movements were then noticed. The right rectus abdominis muscle, however, was raised above the surface plane and felt rigid to the touch, and upon manipulation it hardened up. At the instant of this spasm the patient complained of pain shooting upward from the muscle to the back, and lodging itself in the inter-scapular region at the level of the spinous process of the sixth dorsal vertebra. Thence it spread to the shoulders arms and thorax.

After the administration of nitro-glycerine, gr. $\frac{1}{100}$ th, pain subsided, and spasm—which held the rectus abdominis muscle rigid and taut—relaxed. It was then that I heard for myself the gurgling abdominal sounds which had previously been described by the patient and also by his wife, and with a stethoscope on the abdominal wall, I was able to locate the region whence they came, namely, the left hypochondriac. Here could plainly be heard the rushing sounds of gas moving under considerable pressure, and these sounds continued for one hundred or one hundred and fifty seconds after the place whence they came had been located.

Upon the same afternoon, some two hours after this phenomenon had occurred, a painful attack came on without apparent provocation, flexing the thighs upon the abdomen and convulsing the frame with tetanic and clonic spasms.

For several days afterwards attacks were of frequent occurrence. They were of three kinds, namely :—

(a) Clonic spasms affecting the shoulders, neck, arms, and legs, appearing and passing off without exciting pain.

(b) Tetanic contraction of muscles, violent in character, affecting the epigastrium and the thoracic wall, in which pain and displacement of gas were prominent features. During these attacks, hypertonus of

intercostal and epigastric muscle, led to an extensive propagation of cardiac impulses and sounds, which could be felt and heard over the area of epigastric and left hypochondriac regions. Selected cases of angina pectoris.

(c) Attacks which combined the chief characteristics of the two kinds of seizure already described.

By December 10th, seizures had ceased to occur. On this date the condition of the patient is as follows :—Urine, otherwise normal, deposits uric acid in quantity when cold, and contains a trace of albumen, from which it was free before the series of seizures began. The pulse is maintained at eighty-five beats a minute, a rate noticed on several occasions previous to the occurrence of seizures. Cardiac dulness extends well over the right border of the sternum.

Impulse of the apex beat is feeble, tender spots, not formerly noticed, are now in evidence on both sides of the thoracic wall, being particularly pronounced over the fifth, sixth, and seventh, ribs and interspaces, and over the attachments of the right rectus muscle in the epigastric region. Strands of brachial plexuses in the posterior triangles of the neck and branches of these plexuses in the arms are tender upon pressure. Integuments over spinous processes of the three lower cervical vertebræ and the six upper dorsal are algesic, tenderness becoming more acute upon deep pressure.

The patient usually sleeps from ten o'clock p.m. to four a.m., with head and shoulders supported upon a single, large, thick pillow. He then awakes with a start, feels breathless, and sits up in bed. He has a sense of fullness at the epigastrium, and a desire to retch. If he be able to throw flatus from the chest, dyspnoea subsides, and he lies down and goes to sleep again until the morning. When unable to bring up gas his discomfort continues, and breathing may become difficult, so he is constrained to spring from his bed and walk the room, taking from time to time what rest he may, in an

Selected cases of angina pectoris. easy chair. Sometimes, after pacing the floor of the room for half-an-hour or more, and after sipping hot water, the attack subsides as suddenly as it came on.

These attacks of dyspnoea always begin suddenly and end suddenly. There is some oedema of the legs which has increased of late, and there is dulness over the bases of the lungs with a few moist sounds. The liver extends two inches below the border of the ribs. Morning and evening temperatures are normal.

On December 20th, a rontgen ray examination was made one hour after a bismuth and porridge meal had been taken. The heart is large, extending from a point an inch outside the nipple line on the left side, and on the right to a line midway between the nipple and border of the sternum. A dark shadow in the hypogastrium indicates that the greater part of the meal has left the stomach and has travelled some distance down the intestine. The stomach is small and casts a small shadow. The greater curve is situated on a plane two inches above the umbilicus. It was observed to rise to a level one-and-a-half inches higher after the patient had engaged himself for several minutes in beating time on the floor, but when he ceased making this movement it again fell to the level at which it stood before he began to beat time.

Before the period characterized by seizures commenced, dyspepsia associated with gastric and general abdominal tension was a marked feature seldom absent. Blood pressure was maintained upon a high normal standard. Pulse rate was quick, usually about eighty beats a minute. When strenuous exercise was engaged in, soon after meals, breath became short but no cardiac murmur nor other signs of cardiac irregularity were observed. The jugular curve showed normal deflections, except in the character of the "y" depression,

which was shallow, sometimes to almost total extinction, the "v" wave then becoming merged into the "a" wave.

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During the period of seizures the right heart became noticeably larger and dyspnœa a prominent symptom. It was then observed that the rhythm of the heart was broken by frequent extra systoles. Tracings were taken of jugular and radial pulses both during seizures and at intervals between them. No alteration was observed either in the curve or in its deflexion, differentiating the periods of seizure from periods when no seizures were occurring.

A few weeks after seizures had ceased to appear cardiac symptoms assumed a grave aspect. The pulsus alternans appeared, and extra systoles became frequent. The patient now was unable to lie down on account of dyspnœa and slept with shoulders raised and supported by many pillows. Anasarca increased and involved the thighs, back, abdominal wall and scrotum. A regurgitant murmur was heard at the apex. The jugular curve became featureless, and showed little more than respiratory waves.

The latest observation was made on May 5th, four months after the last seizure. There was no improvement in the general condition of the patient, and cardiac symptoms remained but became more urgent. The pulsus alternans, disappearing at intervals, recurred. The right heart remained large. Extra systoles, arrhythmia, orthopnœa were ever present, and attacks of dyspnœa occurred upon slight provocation.

About a week after this observation had been made the patient died in the night. Death was sudden. Colour left his face, and respiration, which had been rapid, ceased.

The significant feature in this case is the appearance of the segmentary reflex neurosis in the course of the chronic gastric disorder, manifesting itself in the first instance by a

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rapid beat rate of the heart, night attacks of gastric hypertonus, associated with dyspnoea, and later by seizures of clonic spasm and angina pectoris. The presence of the segmentary reflex neurosis is confirmed by the advent of the pathognomonic symptoms, namely, rigidity of muscle and algesia. The angina pectoris was not attended by cardiac disturbance so far as could be ascertained by a study of graphic records of jugular and radial curves traced at the moment when seizures were actually taking place. Indeed, cardiac symptoms did not force themselves into notice in a prominent form until after seizures had ceased to manifest themselves. The cardiac disorder culminating in pulsus alternans was progressive and might be accounted for by the implication of cardiac nutritional centres in the neurosis.

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Part III. Classification.

Chapter XI.

The Angina Pectoris belongs to the Class of
Segmentary Neurosis.

- Section 1. Resemblance in Symptomatology, Ætiology, and Pathology between the Angina Pectoris and Members of the Class of paroxysmal Spasmodic Disorders.
- Section 2. Comparison made between the Angina Pectoris and the simple Vomiting Attack.
- Section 3. The Hysterical Group.
- Section 4. Disordered Sexual Function in the Male.
- Section 5. Palpitation.
- Section 6. Summary.

Section 1. *Resemblance in Symptomatology, Ætiology, and Pathology between the Angina Pectoris and Members of the Class of Paroxysmal Spasmodic Disorders.*

IN this chapter I intend to give reasons for a statement made at an earlier part of the work, namely, that the angina pectoris is a member of the class of paroxysmal spasmodic disorders. Before Sir William Jenner had conceived

1. Angina pectoris belongs to the class of spasmodic disorder.

1. Angina pectoris belongs to the class of spasmodic disorders.

the plausible doctrine of coronary pathogenesis, Heberden had already tabulated eight reasons for the inclusion of angina in the spasmodic class.

Symptoms common to all types of spasmodic complaints of the alimentary canal and hollow organs, associated with it in developmental history, are such as arise when segmental centres are seats of hyper-irritability. During paroxysmal seizures, which from time to time occur, the complement of functions centred in involved segments, comes into play. Paroxysmal spasmodic disorders, associated with the muscular tunic of the alimentary canal, result from segmentary neurosis. Each segment of the cord, through its connexions with the sympathetic group of nerves, controls functions of viscus or viscera seated in its own particular sectional zone. The chief office of segmental centres of the cord is protective. They secure expulsion of contents of visceral tubes and cavities rendered unsuitable through excessive bulk or irritative properties. In the case of the alimentary tube, this purpose is achieved through a system of segmental reflex arcs, centres of which are lodged in each segment from end to end of the cord. The circuit of reflex function lies between visceral and parietal layers of muscle.

Every segment of the cord is in touch with neighbouring segments upon higher and upon lower planes. Through an upper set of neurous, it is also in touch with centres of brain and medulla. In virtue of this latter connexion, the protective reflex is moved to action through psychological, as well as through physiological and physical impressions. Excitement

of the protective, reflex mechanism results in simultaneous contraction of visceral and parietal layers of muscle and expulsion of contents of stomach and of intestinal tract. So in persons whose nerve centres are somewhat unstable, the taste, sight, or even the bare thoughts of unsuitable food causes nausea, retching, vomiting, and diarrhoea. Disturbance of the emotions through fear, anger, or undue excitement from whatsoever cause arising, or excessive muscular effort has the same effect. Protective reflex function, associated with the musculature of the alimentary canal, is physiological.

§1. Angina pectoris belongs to the class of spasmodic disorders.

But when segmentary centres are subjects of neurosis, physiological activities assume abnormal characters; they are exaggerated, inco-ordinate, incoherent, and lacking in purposeful expression. They are attended by discomfort and by pain, which is not infrequently agonizing. They are accompanied by disturbance of vaso-motor, cardiac, and secretory functions. Moreover, high or low systemic blood pressure is a common feature. Indeed, every functional centre in the segmentary commune engages itself in disorderly activities. These abnormal phenomena are characteristic expressions of segmentary neurosis.

Let me give a few examples. In trismus of tetanus, centres guarding the proximal orifice of the alimentary canal are subjects of neurosis. Muscles whose physiological function it is, to close the jaws against the admission of unsuitable bodies into the cavity of the mouth, now exercises their function after an exaggerated manner they fall into spasm, become rigid and groups of somatic muscles in the same zonal system contort the features and stiffen the neck. Other

§1. Angina pectoris belongs to the class of spasmodic disorders.

centres of the same functionary groups are not inactive. The countenance is uncommonly pale, and cold, clammy sweat gathers in drops on the forehead. These latter are indications of activities of vaso constrictor and secretional centres. Sensory centres are outraged, organising pain is felt, and tender spots are found in distributory regions of the fifth cranial nerve.

Similar processes working in another field are observed in the case of hydrophobia, in which complaint, glosso-pharyngeal centres are involved. These centres control traffic between the mouth and stomach. They prevent the passage of foods deemed unsuitable beyond the oral vestibule. Even in health they are highly sensitive to physical, physiological, and psychological impressions. A touch from a soft camel's hair brush, a disgusting taste, the smell, sight, or even the bare thought of putrid or otherwise nauseous meat causes the gorge to rise and to close the canal leading to the stomach. In these activities visceral and parietal groups of muscle are engaged. During pathological activities of hydrophobia the same visceral and parietal groups of muscle are active, but now their activities are exaggerated, disorderly and attended by pain. Even after seizures have subsided, tenderness and rigidity in the functural zone remain.

In case of oesophagismas, gastrismas, entero-spasm, biliary and renal colic, tenesmus, strangury, vaginismus, and utero-spasm, visceral and parietal layers and groups of muscles are contemporaneously engaged in hypertonic and spasmodic action. Each of these several types of spasmodic complaints display during seizures, the complement of symptoms common to the class.

In the symptomatology of all types of the class, cardiac disorder is a marked feature and death when traceable to the complaint, results from cardiac inhibition.

Symptomatology is expressed in the form of paroxysmal seizures. Before seizures begin and after they have ended, subjects of them except for complicating conditions, are apparently well.

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Section 2. *Comparison Made Between the Angina Pectoris and the Simple Vomiting Attack.**

THE symptom-complex called angina pectoris belongs to the class of reflex protective phenomena." So writes Dr. James Mackenzie in his work upon Diseases of the Heart, after putting forward a reasoned argument in favour of the view that angina pectoris is a cardiac reflex.

\$2. Angina and a member of the spasmodic class compared.

In the course of this article evidence opposed to the latter inference is laid before the reader, and proofs are adduced tending to show that the anginal seizure is a gastric reflex, that it is evolved from the painless type of simple gastro-circulatory seizure, and that the entity pain is not an essential content of the syndrome but an excrescent appendage. Much attention is bestowed by writers on angina pectoris in the investigation of the pain symptom, while other symptoms holding a constant place among the contents of the syndrome are allowed to pass unnoticed. By this attitude on the part of observers I am reminded of the tale of the student who, when asked by his examiners to describe an operation, spoke only of the extent of the hæmorrhage. In the anginal

*Reprint from the *Lancet*, June 18th, 1910.

§2. Angina
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attack there is much else worthy of consideration besides pain. Indeed, if pain be eliminated altogether from the field of contemplation symptoms remaining are observed to constitute a complete and harmonious category.

When the anginal attack is considered in regard to its place among paroxysmal seizures it is found to resemble a class associated with functional disorders of the stomach, of which the simple gastro-circulatory seizure commonly known as a vomiting attack is a strong example. The dual syndrome of the simple gastro-circulatory attack represents a series of operations organised for the purpose of protecting the stomach from the effects resulting from the intrusion of a noxious body. The gastric group of operations have for their object neutralisation of the offensive properties of the irritant and its ejection from the gastric cavity; the circulatory group the defence of tissues of the gastric wall and repair of its lesions.

Gastric operations are divisible into three groups—namely: (*a*) Operations for furnishing a direct and open path between the cavity of the stomach and the exterior of the body for the rapid discharge of gastric contents. These operations are accompanied by an abundant flow of saliva to dilute and neutralise the contents of the stomach and to lubricate passages. (*b*) Operations for the provision of a firm and fixed diaphragmatic cushion against which the stomach may be compressed. (*c*) Operations determining the compression of the stomach against the inflated diaphragmatic cushion, and the ejection of gastric contents.

The circulatory syndrome represents operations engaged in with the object of counteracting the effects produced on the tissues of the gastric wall by the presence of an irritant body in the stomach. These operations consist of two groups:—
1. The provision of an abundant supply of blood to the splanchnic region. 2. The establishment of compensatory constriction of the stream bed in somatic and thoracic regions.

When the gastric crisis approaches, as that arising from the presence in the stomach of an irritant, the stream bed in the splanchnic region undergoes augmentation and furnishes accommodation for a large additional influx of arterial blood. Precisely the same thing happens in the case of a limb or other organ under irritation or lesion. The purpose of the operation is to supply the affected region with nutrient fluid and leucocytes in abundance for the means of repair and for the requirements of defence. The purpose of constriction of the stream bed of somatic and thoracic regions is to hasten the current of the arterial blood stream in the direction of the scene of irritation and to maintain the standard elevation of general systemic blood pressure which would otherwise fall to a level so low as to endanger the integrity of all circulatory processes.

Schema A.

In this table gastric and circulatory operations which take place to counteract the presence of an irritant in the stomach are enumerated in the first column, while in the second appear symptoms representing these operations.

The Gastric Syndrome.

(a) *Establishment of a free, open, and direct œsophageal path for the outward passage of the gastric contents and the abundant secretion of saliva for the purpose of dilution and lubrication.*

Operations.

Dilatation of vessels distributed to lacrymal, nasal, buccal, pharyngeal and submaxillary glands exciting a flow of secretion for the purpose of lubricating the passages.

Coordinated action of mylohyoid, hyoglossus, and other pharyngeal and laryngeal muscles for the purpose of opening and straightening the passage, and for conveying saliva into the œsophagus and stomach.

Contraction of fibres radiating from the cardiac end of the œsophagus, thus opening the lower end of this tube, associated with inspi-

Symptoms.

Free flow of saliva and watery fluids into the mouth and pharynx.

Swallowing movements.

Retching.

§2. Angina and a member of the spasmodic class compared.

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ratory efforts distending it with
air. Hypertension of gastro-mural
muscle.

(b) *The provision of a firm and fixed diaphragmatic cushion.*

Operations.

Symptoms.

Deep inspirations.

Attempts at deep inspiration.

Closure of the glottis.

Laryngeal spasm.

Fixation of diaphragm.

Inability to take deep breaths.

Fixation of thoracic muscles.

Sensations of tightness and con-
striction of the chest.

(c) *Compression of the stomach against the fixed diaphragmatic cushion
and the ejection of the gastric contents.*

Contraction of the gastro-mural
muscle.

Sense of gastric tension. Eruc-
tation of flatus.

Spasmodic and violent contrac-
tions of abdominal muscles.

Vomiting.

The Circulatory Syndrome.

(a) Vaso-dilation in the splan-
chnic region.

Fall of blood pressure, faintness,
pallor, coldness of the skin, small
pulse, shrunken veins, feeble beat
force, slow pulse-rate, irregular
rhythm with intermissions or extra
systoles, abundant flow of pale
urine.

(b) Compensatory vaso-constric-
tion in the somatic and thoracic
regions.

Rapid pulse rate, constricted
arteries, sweating.

The circulatory syndrome occurring in the simple gastro-circulatory attack corresponds with the period of nausea and faintness which precedes the act of expulsion of the gastric contents. When the medullary centres of the gastric mechanism are in a robust state the duration of this period is exceedingly short and may pass unnoticed. When these centres are sluggish, as in many forms of dyspepsia, it is prolonged for many minutes or even for one or two hours. It sets in with a falling blood pressure. The shifting of the bulk of the blood stream from the somatic to the splanchnic region leaves the surface arteries and veins alike empty. The pulse is soft, irregular, and intermitting. The skin is cold and pallid,

withdrawal of blood from the medullary centres and brain leads to perverted sensations, abnormal cardiac action, disordered breathing, a sense of giddiness and faintness, and even total insensibility.

\$2. Angina and a member of the spasmodic class compared.

When compensatory vaso-constriction is feeble these symptoms are exaggerated. When spasmodic and local they may be found associated with hard tight arteries and a thread-like pulse or other evidences of vaso-constriction. The series of cases now cited represent the gastro-circulatory attack in several of its phases.

CASE 1. *Dr. X's experiences*.—"It was the custom in a school at which I received my early education for the boys to run at a jog trot pace several times round an enclosed space just after a full meal of milk and bread and butter. During the final lap or before this stage in the course had been reached I often found my breath to be giving out and when I could go no further I used to throw myself down and remain full length upon the turf until my breath returned. On these occasions I experienced sensations of faintness, breath hunger, giddiness, and throbbings at the chest, and sometimes hiccough and retching. On account of many of my school fellows suffering in a like manner as myself, representations were made to the house master and orders were given for the meal to be served after the run instead of before it. Under the new rule attacks of this kind seldom occurred."

CASE 2. *Newspaper reports*.—Death of a girl, aged 17, at a skating rink, May 4th, 1910. Medical evidence showed that death was due to heart failure caused by exercise following a rather heavy meal.

CASE 3. *The experiences of a chronic dyspeptic*.—"On March 10th, 1910, when leaving Victoria Station on my way to the Strand no sign of gastric or circulatory disturbances were noted. My way lay along Victoria Street, and when the Army and Navy Stores were approached feelings of gastric distension and a desire to eructate flatus declared themselves. These sensations were ignored and the walk was continued until the porch of the Westminster Palace Hotel came in sight. I then experienced a distressful sensation in the chest, painless in character, but like that of 'lost breath' or 'air hunger' felt during an exhausting race; my muscles refused to carry me forward. The pulse was small and feeble, with a beat rate of 96 per minute. It was interrupted by frequent intermissions. The veins on the dorsal aspect of my hands, usually of large calibre, were shrunken to threads. While still halting I retched several times and succeeded in dislodging a considerable volume of flatus from the stomach. The sensation of distension relieved, the pulse again began to run an even course without intermissions. No further signs of circulatory disturbance manifested themselves before my destination was reached."

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CASE 4.—Recently a chronic dyspeptic gave me the following account of his experience :—"After a meal of sandwiches and ale I contested an impromptu race. The course lay on a steep incline crowned by a long flight of stairs. Gaining the lead in the first 200 yards I retained it, and, mounting the stairs without halting, I reached the summit alone. But no sooner had I come to a standstill than everything seemed to be swimming around me. My sight became dim, and, unable any longer to keep my feet, I sank to the ground in a semi-conscious state gasping for breath. Here I lay for several minutes feeling much oppressed at the chest, but upon bringing up a large quantity of flatus I soon began to recover, and felt quite well again in 10 or 15 minutes.

CASE 5.—Mr. A., who had been known to me for some years as a gross eater, went to bed one night after a late dinner apparently in the enjoyment of good health. At 2 o'clock on the following morning I was called to see him. His face was pallid and bathed in perspiration. His hands were pale, cold, sweating, and shrunken, and the veins at their dorsal aspect were represented by tiny blue threads. His pulse was small, feeble, rapid, and interrupted at every few beats by intermissions. He occasionally yawned, hiccupped, swallowed saliva, and retched, and saliva was noticed to trickle from the corners of his mouth and had already wet the covering of his pillow and the front of his night shirt. He was squinting and the muscles of his face twitched. He was not conscious of my presence. His pulse upon a second examination was almost imperceptible, his breathing became shallow and irregular, and a snoring whistling sound was heard with each laboured inspiration. He had sunk down in bed, his head was flexed on his neck, and his chin rested on his chest.

The pillow and bolster were removed and his head was drawn over the side of the bed and depressed with the double object of encouraging a flow of blood to the medullary centres and a better supply of air to the lungs. At the same time my fingers were forced into his throat to discover if any lodgment of food had taken place in the neighbourhood of the aperture of the glottis. While my fingers were still in his throat he gulped up a large quantity of gas. Convulsive vomiting efforts followed, resulting in the expulsion of half a gallon of dark fluid mixed with undigested food. Ten minutes later the patient was sitting up in bed, and in answer to an inquiry said he felt quite well.

When attacks such as those endured by Mr. A. result in the expulsion of the contents of the stomach by vomiting, the purpose underlying the symptoms becomes manifest.

Having now examined and tabulated the processes and symptoms occurring in the painless type of the simple gastro-circulatory attack, we are in a position to approach the consideration of the painful type—namely, angina pectoris—to hold up for comparison all that appertains to these two types of seizure.

When the anginal seizure is stripped of its pain symptoms, the symptoms remaining may be divided into two categories, a gastric and a circulatory, and each of these differentiated groups is observed to stand alone as a complete organic entity, while together they form a dual syndrome. Each section of the dual syndrome represents a purpose, and processes in operation for carrying the purpose into effective consummation. So every symptom in the contents of the respective syndromes is a sign or outward manifestation of a process of the gastric or circulatory mechanism working towards a definite and determinate end.

§2. Angina and a member of the spasmodic class compared.

If the syndrome of the gastric and circulatory symptoms of the anginal seizure be examined closely they are observed to afford evidence of the existence of processes in operation, animated by purposes precisely similar to those manifested in the dual syndrome of the simple gastro-circulatory attack. There is this difference, however, between the two types of seizure. In the robust forms of the simple gastro-circulatory attack the processes in operation as represented in the gastric section of the dual syndrome are perfectly coördinated and sufficiently effective to accomplish their end, and the attack terminates in expulsion of the contents of the stomach; whereas in the case of the anginal seizure the processes in all their operations are inefficiently organised and abortive, and the purpose of the seizure usually remains unfulfilled.

Every entity in the contents of the gastric section of the dual syndrome of the anginal seizure is then to be regarded as a feeble or exaggerated reflexion of a symptom having a place

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in the corresponding syndrome of the robust forms of the simple gastro-circulatory attack. It therefore follows that while the purposes and the operations manifested in the parallel syndromes are alike in their nature and essence, the presentations of these operations in the respective seizures are dissimilar.

A significant illustration of this unity of purpose and operation and inequality in presentation, furnished by the two types of seizure, is observable in a well-defined group of symptoms—namely, that which represents the operations of the gastric mechanism having for its object the formation and fixation of a firm diaphragmatic cushion against which the stomach may undergo compression during the final act of vomiting. This end is attained to perfection in the robust form of simple gastro-circulatory attack, while in the anginal seizure the accomplishment of the same purpose is attempted by imperfectly coördinated efforts.

The processes engaged in the operation are as follows :
(a) Inflation of the chest with inspired air ; (b) closure of the aperture of the glottis ; and (c) contraction and fixation of the diaphragmatic, intercostal, thoracic, and cervical muscles. For the purpose of comparison the operations occurring in the simple gastro-circulatory attack and the symptoms presented in the anginal seizure are placed side by side in parallel columns.

A group of operations occurring during the simple gastro-circulatory attack.

(a) Inflation of the chest with inspired air.

A corresponding group of symptoms presented during the anginal seizure.

"The patient has to stand still and take a great deep inspiration."

(b) Closure of the aperture of the glottis.

(c) Contraction and fixation of the diaphragmatic, intercostal, thoracic, and cervical muscles.

(Mackenzie : Diseases of the Heart, §2, Angina and a mem-
p. 46.) ber of the

" *There may be laryngeal spasms.*"
(R. Quain : Dictionary of Medicine, class
p. 53, 1882.) compared.

" *The breathing is disturbed, oppressed, and restrained.*" (Douglas
Powell : Allbutt's System, vol. vi.
p. 48.)

" *The breathing is sometimes distressing, although the patient can take a deep breath when asked to do so.*" (Bristowe's Medicine, p. 53.)

" *A sense of constriction as though the heart was gripped or the thorax were severely pressed.*" (Douglas
Powell : Allbutt's System, vol. vi.,
p. 47.)

" *Feeling of great tightness over ribs.*" Ross : Brain, vol. x., p. 355.)

" *Pain is generally attended with a sense of constriction.*" Bristowe's
Medicine, p. 519.)

" *Pain associated with a sense of constriction 'as if a mailed hand grasped the chest.'*" (Balfour :
Twentieth Century of Medicine,
p. 445.)

" *Some would limit the term Angina Pectoris to that class of cases where in addition to the pain there is a sense of constriction in the chest, amounting to the sensation at times as if the chest were gripped in a vice. I am convinced that these sensations arise from spasms of the intercostal muscles.*"
(Mackenzie : Diseases of the Heart,
p. 36.)

Another series of symptoms may be observed in the anginal seizure which have a prototype in the simple gastro-circulatory, and in both represent process in operation for diluting and neutralising the contents of the stomach and for opening, straightening, and lubricating the œsophagus. These processes consist in the secretion of an abundant flow of saliva, swallowing movements, and retching.

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Dr. Mackenzie frequently mentions the abundance of the flow of saliva and describes the process of retching. His evidence is the more valuable because it is adduced in favour of a theory not in accord with my argument. It occurs in a statement to show the eructation of flatus which is a common symptom in angina pectoris is the result of "air swallowing." He writes: "Another symptom is extremely common in these cases" of angina pectoris—namely, "the belching of air. . . . Before expelling the air patients unconsciously close the glottis, fix the muscles of the abdominal wall, then expand the chest." "By this process they suck air into the stomach, after sucking in a quantity they expel it with considerable force."¹

Compare this description of symptoms of an anginal seizure from Mackenzie with that of the simple gastro-circulatory or vomiting attack by Starling. "The act of vomiting is generally preceded by . . . copious salivation and retching. Retching is a violent inspiration while the glottis is kept firmly closed, so that air is drawn into the œsophagus and distends it. This stage is followed by contraction of the fibres radiating from the cardiac end of the œsophagus which opens and allows gas to escape."²

In the simple gastro-circulatory attack there is a third group of processes also represented in the anginal seizure—namely, those connected with the expulsion of food from the stomach. They consist of closure of the pyloric orifice, con-

¹ Mackenzie: *Diseases of the Heart*, p. 55.

² Starling's *Physiology*, p. 369.

tractions of gastro-mural muscle, and compression of the stomach between the abdominal walls and the inflated cushion of the diaphragm. These processes are represented in the anginal attack by a sense of gastric tension, by forcibly expulsion of flatus, and by vomiting.

§2. Angina and a member of the spasmodic class compared.

Vomiting, as might be expected, is a somewhat rare incident in the anginal seizure where the processes of the gastric mechanism are imperfectly coördinated, but it is occasionally described as occurring. It is spoken of by Douglas Powell. "The patient vomits and becomes easier."³ On the other hand, eructation of flatus is a common feature in every attack. Dr. Mackenzie says: "The case may end by expulsion of air from the chest."⁴ "Eructation gives relief."⁵ And, again, Mackenzie: "Another symptom is very common in these cases, the belching of air." "The chief feature is the noisy expulsion of air from the stomach."⁶

So far I have only spoken of the gastric syndrome, but the anginal attack, like the simple gastro-circulatory, has a dual syndrome—gastric and circulatory.

In the circulatory syndrome, as in the gastric, a purpose is discernible and the symptoms manifesting it present themselves in boldest outline when the seizure is prolonged. They appear in the period of faintness and pallor, and are contemporary with an influx of arterial blood to the splanchnic region and a withdrawal of the red stream from the somatic

³ Allbutt's System, vol. iv., p. 49.

⁴ Disease of the Heart, p. 47.

⁵ Dr. Powell, Allbutt's System, vol. vi., p. 49.

⁶ Heart Disease, p. 55.

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and thoracic areas. The same thing occurs in other regions of the body in the presence of an irritant. Local vaso-dilatation is always associated with general compensatory vaso-constriction, and the purpose underlying this disposition of the blood stream is the abundant supply of leucocytes and plasma for the protection and repair of the injured organs.

In the circulatory syndrome of the anginal attack the gastric crisis is a predominant factor, and the splanchnic vessels are the scene of great arterial activity, the outlying regions being drained dry of the stream. Every symptom in the syndrome bears witness to the determination of the greater bulk of the stream to the splanchnic field of distribution of the stream bed, and no sign is found existing in the course of the syndrome which opposes itself to an interpretation of the symptoms in accordance with this hypothesis.

The points of resemblance between the circulatory syndrome of the anginal attack and the corresponding syndrome of the simple gastro-circulatory are many and significant. In both there is a falling blood pressure, venous and arterial, although instances may occur in which blood pressure is sustained at a high elevation on account of organic constriction and obliteration of large circulatory tracts in the splanchnic region as in some forms of nephritic and hepatic disease. Moreover, a fall in blood pressure may be arrested and the movement in the mercury of the manometer reversed through the operation of vigorous compensatory changes in the stream bed, or by an augmentation in the driving force of the heart or an increase in its beat-rate.

In the anginal seizure, as in that of the simple gastro-circulatory, pallor, coldness, sweating, and other signs of depletion and attenuation of the somatic stream are in evidence. In both, moreover, symptoms are present pointing to a recession of the stream from medullary and cerebral centres, and even the heart itself shows signs of blood hunger and a variety of resultant disturbances. The incidence of compensatory vaso-constriction at a time when the heart and vessels of the upper part of the body are depleted of the red stream would tend towards the encouragement of spasmodic, crampy, and irregular contractions of cardiac and arterial muscle. The spasmodic and patchy nature of the vaso-constrictive impulse may be gathered from the following extracts.

§2. Angina and a member of the spasmodic class compared.

Heberden reports a case of asphyxia of the left forearm and hand in which the extremity would suddenly become cold during the attack. Trousseau also reports a case where extreme pallor was followed by a pronounced violet and bluish colouration of the arm and hand, the natural colour being restored as soon as the pain ceased. Balfour records the case of a lady whose attacks were always preceded by pallor of the face and fingers, and Bristowe speaks of the affected limb becoming pale and cold. Douglas Powell relates a case where during the attack the pulse was very small, scarcely perceptible, but very hard and thready. In another case he speaks of the pulse being small and thready, and of a third he says : " An attack of pain came on attended with quickened action of the heart and diminution in size

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and increase in tightness of the pulse; the diminution in size proceeding almost to extinction, a mere tightened thread being felt under the finger." On the other hand Mackenzie states that he has "never found a single case where the arteries were constricted in the manner sometimes described.

Angina pectoris, like the simple gastro-circulatory seizure, presents two prominent clinical varieties—namely, an attack coming on during exercise and ending upon the cessation of exercise; and a form of attack which generally begins in a period of rest and runs an independent course. An illustration of the former clinical variety is now given in the patient's own words:—

"On November 19th, 1909, I was called to visit a patient residing at a distance of a mile from my own door, and having at hand no means of conveyance for hastening the journey I set out on foot. My path lay along a road of easy and falling gradients and for the first hundred yards all went well with me. But soon afterwards I began to be conscious of discomfort at the præcordial region, and this sensation was accompanied by feelings of abdominal distension and a desire to expel gas from the chest. The præcordial uneasiness at length grew into pain, extending to both sides of the thorax and to the arms. The pulse had now begun to run rapidly, with intermissions at the end of every five or seven beats. It was small, feeble, and compressible. After a rest of a few minutes' duration, which brought relief, I continued on my way, but I had not gone more than seventy or eighty paces further when pain and sensations of gastric distension recurred and under the influence of rest or the expulsion of flatus again abated. These experiences were repeated several times before I came to the end of my journey."

Schema B.

Comparison of the symptoms of the painful type of the simple gastro-circulatory seizure with those of the painless.

Symptoms of painless type of simple gastro-circulatory attack.

Symptoms of the painful type of gastro-circulatory attack or angina pectoris, observed by authors and recorded by them.

Gastric Syndrome.

(a) *Symptoms representing operations engaged in with the object of opening, lubricating, and straightening the œsophageal tube.*

(1) Free flow of saliva.

"Abundant flow of saliva."

- (2) Swallowing movements.
- (Mackenzie: Diseases of the Heart, p. 39.)
- Swallowing movements.*
"Air-sucking and swallowing." (Ibid., p. 55.)
- (3) Retching.
- "Difficulty in Swallowing."* (R. Quain: Dictionary, p. 53.)
- "Erectation."* (Mackenzie: Heart Disease, p. 47; Douglas Powell: Allbutt's System, vol. 5, p. 48.)
- "Flatulence is often present."* (R. Quain: Dictionary p. 51.)
- (b) Symptoms representing operations engaged in with the object of the establishment of a firm diaphragmatic cushion.
- (1) Deep inspiratory act.
- "The patient has to stand still and take a great deep inspiration."* (Mackenzie: Diseases of the Heart, p. 16.)
- (2) Fixation of the muscles of the chest wall.
- "Pain associated with feelings of constriction as if a mailed hand grasped the chest."* (Balfour: Twentieth Century of Medicine, p. 445.)
- "Thorax compressed."* (D. Powell: Allbutt's System, vol. vi., p. 48.)
- "Sense of fixation of the chest walls."* (Mackenzie: Diseases of the Heart, p. 45.)
- "Fixation of the chest."* (Whittaker: Twentieth Century of Medicine, p. 445.)
- "Tightness across the chest."* (Mackenzie: Diseases of the Heart, p. 45.)
- "A sense of constriction independent of pain."* (Ibid., p. 45.)
- "Grips the chest, causing patient to take deep inspiration."* (Ibid., p. 45.)
- "Sense of contraction of chest."* (Bristowe's Medicine, p. 519.)
- "Feeling of great tightness over ribs."* (Ross: Brain, vol. x., p. 355.)
- "Cannot take deep breath."* (Bristowe's Medicine, p. 519; Quain's Dictionary, p. 50.)
- "Breathing oppressed and restrained."* (D. Powell: Allbutt's System, vol. vi., p. 48.)
- (3) Contraction of the diaphragm and muscles closing aperture of the glottis. Hiccough.
- "Diaphragm involved."* (R. Quain, Dictionary, p. 50.)
- "Laryngeal spasm."* (Ibid. p. 50.)

§2. Angina and a member of the spasmodic class compared.

(c) *Symptoms representing operations determining the expulsion of the gastric contents.*

(1) Attack terminates in eructation of flatus.

"The case may end by expulsion of air from the chest." (Mackenzie: Diseases of the Heart, p. 47.)

"Eructation gives relief." (D. Powell: Allbutt's System, vol. vi., p. 49.)

(2) Attack terminates in expulsion of gastric contents.

"Patient vomits and becomes easier." (Allbutt's System, vol. vi., p. 49.)

Circulatory Syndrome.

Painless type of simple gastro-circulatory attack.

Painful type of gastro-circulatory attack (angina pectoris.)

(a) *Symptoms representing operations determining influx of arterial blood to the splanchnic region.*

(1) Falling blood pressure.

"Blood pressure falls during attacks." (Mackenzie: Diseases of the Heart, p. 47.)

(2) A copious flow of pale urine follows the attack.

"A copious flow of pale urine." (D. Powell: Allbutt's System, vol. vi., p. 33.)

"Urine always pale, abundant, and of low specific gravity." (Mackenzie: Diseases of the Heart, p. 47.)

"Urine passed in abundance." (R. Quain: Dictionary, p. 51.)

(3) Disturbance of beat-rate.

"Pulse 120." (D. Powell: Allbutt's System, vol. vi., p. 50.)

"Pulse-rate slow." (Mackenzie: Diseases of the Heart, p. 47.)

"Decidedly infrequent." (D. Powell: Allbutt's System, vol. vi., p. 48.)

"Heart often beats twice to one radial pulse." (Ibid.)

"Pulse 100." (Ibid.)

"Pulse rapid beyond computation." (Verdon: Heart, vol. 1., p. 230.)

(4) Beat force feeble

"Beat force feeble." (Mackenzie: Diseases of the Heart, p. 47.)

"Pulse weak." (D. Powell: Allbutt's System, vol. vi., p. 50.)

(5) Artery small.

"Artery small but no spasmodic contraction." (Mackenzie: Diseases of the Heart, p. 47.)

"Pulse scarcely perceptible." (Bristowe's Medicine, p. 520.)

(6) Rhythm irregular; intermissions.

"*Rhythm irregular, intermissions.*" (Mackenzie: Diseases of the Heart, p. 47; D. Powell: Allbutt's System, vol. vi., p. 50.) §2. Angina ber of the spasmodic class compared.

(7) Constricted veins.

"*Constricted veins.*" (Verdon.)

(8) Pallor.

"*Pallor.*" (D. Powell: Allbutt's System, vol. vi., p. 48.)

"*Face pallid.*" (R. Quain: Dictionary p. 50.)

"*Face suddenly becomes pale.*" (Bristowe's Medicine, p. 519.)

"*Surface of body becomes pallid.*" (R. Quain: Dictionary, p. 50.)

(9) Coldness of skin.

"*Whole surface of body cold.*" (Ibid.)

"*Coldness of surface.*" (D. Powell: Allbutt's System, vol. vi., p. 48.)

"*Suddenly becomes cold.*" (Bristowe's Medicine, p. 520.)

(10) Faintness.

"*Sense of faintness.*" (R. Quain: Dictionary, p. 51, 1882.)

(b) Symptoms representing operations determining compensatory vaso-constriction in the somatic and thoracic regions.

(1) High tension of arterial wall.

"*Pulse small, hard, thready, and scarcely perceptible.*" (Allbutt's System, vol. vi., p. 50.)

"*Diminution in size of pulse proceeding to almost extinction, a mere tightened thread being felt under fingers.*" (Ibid., p. 49.)

"*Small pulse and of high tension.*" (Ibid., p. 34.)

(2) Splanchnic effect upon sweat glands.

"*Streaming with perspiration.*" (Ibid., p. 50.)

"*Covered with sweat.*" (R. Quain: Dictionary, p. 50.)

"*Cold sweat.*" (Allbutt's System, vol. vi., p. 47.)

"*Clammy sweat.*" Bristowe's Medicine, p. 519.)

Further Points of Comparison.

Painless type of simple gastro-circulatory attack.

Painful type of gastro-circulatory attack (angina pectoris).

(1) An attack is excited in the predisposed by oscillatory movements of the body occasioned by walking, running, swinging, or by a heaving movement as when aboard a boat at sea.

"*Exercise induces an attack.*" (Bristowe, p. 519.)

"*On taking exercise premonitory systems are felt.*" (D. Powell: Allbutt's System, vol. vi., p. 48.)

§2. Angina and a member of the spasmodic class compared.

The attack is hastened by the presence of food, fluids and flatus in the stomach.

In some cases of gastro-circulatory attack in which irritability of the stomach or its nerve centres is a marked feature, a change of position from the horizontal to the vertical, rising from a chair, or walking across a room may precipitate an attack.

(2) Another variety of attack is excited by the presence of offending bodies in the stomach, often resulting from delays of digestion, the retention of undigested food, and the biochemical changes taking place in it.

The attack comes to an end after the expulsion of the offending bodies.

(3) An attack sometimes comes on as a result of sensory impressions or strong emotion.

(4) The attack does not always come to an end upon the cessation of the impression which excited it. It is then probably caused by a chronic irritable condition of the nerve centres, or by the presence of a toxin in the blood stream.

(5) The attack often comes to an end upon the administration of amyl nitrite, or nitro-glycerine.

"Flatulent distension of the stomach is frequently an exciting cause" of anginal attacks. (D. Powell: *Allbutt's System*, vol. vi., p. 29.)

"Flatulent distension is a frequent concomitant of anginal paroxysms." (Ibid.)

"An oppressive meal of indigestible food brought on a first and distressing anginal attack followed by others." (R. Quain: *Dictionary*, p. 53, 1882.)

"In one of Stoke's patients the slightest muscular effort—that simply of moving his feet in bed—sufficed to precipitate an attack. The patient therefore went to bed wearing his clothes." (Whittaker: *Twentieth Century of Medicine*, vol. iv., p. 444.)

"Dyspepsia is a frequent exciting cause of anginal attacks." (D. Powell: *Allbutt's System*, vol. vi., p. 29.)

"The case may come to an end by expulsion of air from the chest." (Mackenzie: *Diseases of the Heart*, p. 47.)

"Patient vomits and becomes easier." (D. Powell: *Allbutt's System*, vol. vi., p. 49.)

"Emotional disturbance, fright, and pain will produce attacks." (*Allbutt's System*, vol. vi., p. 29.)

"Amyl nitrite acted instantaneously." Mackenzie: *Diseases of the Heart*, p. 50.)

Many of the symptoms referred to in the above schema, such as coldness of the skin, sweating, and pallor, when looked upon singly appear of little significance, but when seen as

members of the orderly array of symptoms constituting the syndrome their importance is self-evident. They are then recognised as marks representing processes which move in obedience to economic purpose.

§2. Angina and a member of the spasmodic class compared.

Thus, when we observe coldness of the skin, general pallor, shrinkage in the calibre of arteries and veins, and an almost empty pulse, we know that attenuation in the volume of the arterial stream traversing the vessels of the somatic region exists, and when we notice the presence of a feeble irregular, and intermitting pulse in conjunction with these symptoms we conclude that the volume of blood entering the heart is also small. Moreover, at the same time proof is not wanting of a dilated state of the vessels of the splanchnic region. A falling blood pressure observed at this stage of the seizure furnishes incontestable evidence of the existence of this condition, and the secretion of an abundance of pale urine retained during the course of the seizure but passed soon afterwards is confirmatory evidence of a strong order.

Consequently it may be inferred that symptoms occurring in the penultimate stages of the painful and painless types of the gastro-circulatory seizure, as scheduled under "Circulatory syndrome, Schema B," alike afford evidence of a circulatory crisis in being, in which the blood stream withdrawn from the coverings of the body, from the nerve centres in the medulla, and from the heart itself is massed in the splanchnic lacuna.

As all processes taking place in the animal organism are set into motion, controlled and directed in accordance with an economic purpose, so the gathering of the bulk of the blood volume in the splanchnic region and its displacement from accustomed channels observed in the gastro-circulatory attack is effected for a definite end. This purpose and the reasons thereof are referred to in the early paragraphs.

The resemblance existing between the painless and painful types of seizures observed in the schema renders it probable

that they both belong to the same group, that the processes underlying the symptoms are directed from the same or associated centres, and in fact that the anginal attack is either a gastric reflex, or springs from direct irritation of gastro-circulatory nerve centres.

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Section 3. *Segmentary Nerves associates certain features of the Anginal Pattern with the Hysterical Group.*

§3. Hysteria
an example of
segmentary
neurosis.

DISTRIBUTARY zones of fourth, fifth and sixth intercostal nerves, define the uterine field in thoracic regions. These nerves innervate mammae and their integumental covering. From these segmentary centres, neurone strands, after passing through stations in sympathetic chains, enter into the formation of splanchnic nerves, and thence traverse solar, hypo-gastric, and pelvic plexuses, finally to reach their destination in uterine, ovarine, and vaginal structures. Along this track, to and fro, between uterus and mammae, sensory and motor impressions are conducted. When the infant is put to the breast, uterine contractions occur. When the uterus is the scene of evolution, mammary structures grow and mammary tubules fill with milk. When uterus falls into functional disorder, irritative impressions are received by fourth, fifth and sixth segments of the thoracic cord, and foci of hyper-irritability are established.

Tender spots on thoracic walls, at points of outcrop of fourth, fifth and sixth intercostal nerves, are not infrequently found during dysmenorrhœa, at the meno-pause, and in cases of utero-spasm and utero-flexion. I have noticed tender spots in distributary regions of these nerves, arising in the course of obstructed labour, and on these occasions, I have witnessed the contemporaneous appearance of cramp in the lower extremities, tender patches on the thighs, rigidity of abdominal muscle, and spasmodic and inefficient action of the muscular tunic of the uterus. This example gives an indication of the effect of continued resistance against the action of visceral muscle, in the causation of segmentary neurosis. Similar central changes, as in the case of the uterus, occur in functional or organic obstruction of the intestinal canal, but centres affected in this latter example are not the same. They are such as serve requirements of the particular portion of musculature, other than uterine, engaged in resisting hyper-tonic action.

§3. Hysteria
an example
segmentary
neurosis.

A mitigated form of segmentary neurosis is very common among females suffering from slight uterine disorders, such as are instigated by uterine flexures or versions, leading to utero-spasm and dysmenorrhœa. This form of segmentary neurosis produces numberless symptoms. When segmentary centres, associated with the musculature of the stomach, are implicated in the uterine neurosis, gastric hyper-irritability occurs. The stomach contracts under low degrees of stimulation, and refuses to entertain gaseous or solid bodies. Frequent eructations of gas occur at all times of the day, and vomiting is

§3. Hysteria
an example of
segmentary
neurosis.

not an uncommon incident. Soon after food is swallowed, it is driven down into the duodenum, unprepared and unpeptonised, and when there, gives rise to uncomfortable sensations. Cardiac centres are invaded, and palpitation is a frequent symptom.

Subjects of this form of neurosis are victims of phenomena, which in a former generation were called by the generic term of the "vapours," which applied not only to the gassy state of the stomach, but also to flatuosity of mind, to which persons suffering from nervous debility and uterine pathology are particularly prone, and in which a variety of strange images float in the brain and appear as if real. Connexion between the fourth, fifth and sixth segments of the thoracic cord and organs of imagination and emotion, through the upper set of neurons, constitutes the anatomical mechanism of hypochondriasis and other symptoms prominent in the psychology of the uterine neurosis.

Among symptoms of this form of neurosis may be numbered vaso motor phenomena and extra systolic and sinus arrhythmia. Sometimes arrhythmia assumes the paroxysmal tachicardial type. Palpitation commonly appearing at the time of the meno-pause, owes its origin to segmentary neurosis.

A feature in hysterical symptomatology, and a subject of remark among clinicians, is the tendency of persons affected by this disorder to manifest groups of symptoms properly belonging to real diseases. Hip joint disease is an illustration in point. I have seen cases in the wards of hospitals diagnosed as hip joint disease, which on later examination have proved

to be examples of hysterical counterfeit. In this instance hysterical processes copy their model in all minutiae of detail, and only when the patient sleeps or when under the influence of anæsthetics is the error in diagnosis detected. In hip joint disease, symptomatology represents protective reflex processes rising into great pre-eminence through hyper-irritability at segmentary centres. Hyper-irritability of centres results from irritative processes, generated in the joint itself. Whereas in the hysterical counterfeit, a mild form of neurosis affects the same segmentary groups, and although derived from another quarter, results in similar symptomatological features. Uterine neurosis is the pathological basis of hysterical symptomatology. It is the instigating agency of "globus" and the predisposing cause of those anginous seizures, not infrequently happening in hysterical subjects, and erroneously described as false or psuedo angina.

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Section 4. *Disordered Sexual Function in the Male.*

SEVERAL subjects of angina have informed me that 4. Segemen-
months before first symptoms of the complaint and disorder-
appeared, sexual function was partially lost. Depen- sexual
function.

dence for efficient function upon sound segmentary centres is sufficient cause for this form of disability, to occupy an

‡4. Segmen-
tary neurosis
and disorder-
ed sexual
function.

occasional place in the symptomatology of angina when centres are not sound.

A case of angina in a man of fifty-five years of age, complicated by weakness of sexual function, came under my notice in the early months of 1914. He was father of a family of stout-limbed children. Formerly sexual function was vigorous. Two years before anginous symptoms appeared it began to fail.

Testes were pendulous and shrunken to half their normal proportions. Scrotal rugæ were absent. The scrotum was glossy, thin as tissue paper, and through it the outline of structures beneath were figured. Genital organs were bloodless, pallid and cold. Dorsal artery rolled beneath the finger like a piece of whip-cord. These signs furnished evidence of local vaso-constriction. The patient was muscular and well-built, and, except for this obsession, sound in all his organs. The strange contrast excited attention.

I have omitted to mention a point of diagnostic value. Integuments of organs were anæsthetic. At early stages of functional distress they are said to have been hyper-æsthetic.

On further examination, several symptoms of interest to us were noted. A pallid, anæsthetic cold patch of integument, about the size of the open hand, was in being at the mid-third of the anterior surface of the thigh, and another patch of similar dimensions and character at the gluteal region. These patches correspond with areas of cutaneous innervation of the genito-femoral nerve. A strange coincidence is in evidence here. Roots of the genito-femoral nerve spring from the tenth segment of the thoracic cord. From this same segment the muscular coat of the spermatic artery derives innervation.

In neurosis of the tenth and adjoining segments of the cord is to be found a clue to the rational interpretation of the scattered symptoms of the syndrome herein described, and

the basal connexion existing between this syndrome and the source of the angina pectoris.

§4. Segmentary neurosis and disorder of sexual function.

The tenth segment of the thoracic cord receives afferent strands from certain abdominal organs, including the duodenum, and in the case under consideration, disturbance at the duodenum is a potential factor worthy of consideration as an agency in the production of the neurosis. Signs were not wanting which signified engorgement of this organ, namely, chronic yellowish grey discolouration of the conjuction, biliary pigments in the urine, flatulent gastric distension, and a prolonged entertainment of food stuffs in the stomach. Another sign was present, which in the absence of obstructive conditions in the colon and rectum may be regarded as pathognomous of distended duodenum, namely, intensive engorgement of the columnar plexus of veins in the rectum.

An engorged columnar plexus indicates an obstructed inferior mesenteric vein. To reach the portal vein the stream of venous blood accumulating in the lacunæ of the columnar plexus must traverse the inferior mesenteric channel. If this vein be followed in its course upwards to its junction with the splenic, it is noticed to pass behind the duodenum, and in this situation, when the organ is full, it is liable to pressure and obstruction. The duodenocaval reflex, described in a later chapter, was possibly the remote agency at work in the production of anginous seizures.

Section 5. *Palpitation*.*

§ 5. Palpitation.

YOUR readers are doubtless sufficiently familiar with accounts of attacks of palpitation given by patients who do not suffer from organic heart disease. Indeed a practitioner cannot expect to end his daily round of visits without hearing something about this complaint. I have had no difficulty therefore in collecting notes of thirty cases from among a class of patients who suffer from this disorder, mostly maiden ladies at the age period of the menopause. In selecting cases for the series I have given preference to those in which seizures have a well-defined beginning and end, and in which they occur at night-time and are associated with errors of dietary.

With some little variation of details, symptomatology is much the same in all. In many instances the only thing noticed by patients is the impulse of the heart beat, which attracts attention especially when the head is laid upon a pillow. Pulsations are heard distinctly by persons lying in this pose, when beat rate may be determined with ease. When pulsations are rhythmic they usually attract little notice, and the attack is forgotten; but when they are arrhythmic they cause anxiety, and the doctor hears of them when he calls next day. Attacks similar to those occurring at night are often repeated during

*Reprinted from the Clinical Journal, August 23rd, 1916.

the day. In most of the series, I have witnessed one or more day attacks. §5. Palpitation.

When a seizure is impending, nervousness on the part of the patient undergoing cardiac examination hastens its advent, and an opportunity is afforded which, if taken advantage of, furnishes the observer with a conception of the state of things before, after and during the seizure.

Symptomatology is not limited to abnormal activities of the heart. Signs are not wanting that the central nervous system is involved. Symptoms pathognomonic of hyper-irritability of segmentary centres of intercostal nerves are present, namely rigidity of intercostal and recti abdominis muscles, and tender spots situated at the outcrop of intercostal nerves.

Rigidity manifests itself in the musculature of the thorax. The walls have a wooden appearance and move little during respiration. Heart sounds and impulses are readily propagated, and they are heard and felt over a wide area, sometimes extending to a plane as low as the umbilicus. When the left rectus abdominis is rigid its epigastric section stands out from the abdominal wall like a new growth and pulsates after the manner of an aneurism. Sometimes the spasmodic contraction of heads of attachment of this muscle to the sixth, seventh and eighth ribs cause pain, and when the left muscle is affected, pain is attributed by the patient to the heart. Sometimes patients describe the heaped-up muscle as a ball of wind pressing on the heart, and try to rub the lump down. Sternomastoid muscles are also subject to rigidity. On one

§5. Palpitation.

or two occasions when seizures were severe I have noticed the skull to rock on its axis with each cardiac impulse. Rigidity of muscles prevents the tracing of any satisfactory record of jugular pulse.

Algesic symptoms, also pathognomonic of segmentary hyper-irritability, show themselves chiefly in the fourth, fifth and sixth intercostal spaces. Tender spots appearing at points of outcrop of intercostal nerves are situated bilaterally. They are often found seated over the chief area of cardiac impulse, and their existence at a corresponding area of the right thorax is not suspected until palpation has revealed their presence. Tender spots over a throbbing and arrhythmic heart lend strength to the belief often expressed by patients that they are suffering from cardiac disease.

Among persons subject to attack adenoid lumps are not infrequently found occupying outer sections of mammary glands, and in intercostal spaces beneath these swellings tender spots lie masked.

Cardiac arrhythmia is of extra-systolic type. In a sequence of pulsations otherwise even, extra-systolic figures are interpolated at frequent intervals.

Symptoms already mentioned, and certain vasomotor phenomena which frequently accompany them, are referable to segmentary neurosis, and since symptoms characterising paroxysmal attacks of every sort are usually referable to a unitary predisposing cause, no question, I think, will be raised when I state that segmentary neurosis is that cause.

But what agency is responsible for the appearance of this

neurosis in women at the climacteric? The situation of tender spots and an occasional appearance of adenoid lumps in the mammæ furnish an answer. Fourth, fifth and sixth intercostal nerves, in the distributary areas of which tender spots chiefly appear, supply glandular tissues of the mammæ. Activity in these glands notably synchronises with phenomena of uterine physiology and pathology. Changes seldom take place in the uterus either at times of the menses, at pregnancy, or at the menopause, without reflecting themselves upon the mammary glands. Moreover, converse activities take place when the infant is put to the breast, for then contractions occur in uterine walls. Affected segments of the thoracic cord are in touch with uterine and ovarian structures through stands of sympathetic nerves which traverse semilunar plexuses and thence take part in formation of hypogastric and uterine plexuses. Uterine or ovarian disturbance at the period of the menopause is well calculated to cause neurosis of segmentary centres.

The exciting cause of the seizure of palpitation is now to be considered. What starts the syndrome? The musculature of the stomach is in afferent connection through cœliac plexuses and splanchnic nerves with every segment of the thoracic cord; we need not look to anatomy for confirmation of this fact. Pain in the thoracic wall and in substernal regions extending from the synchondrosis downwards, which not infrequently follows a meal of cucumber and salmon, offers a clinical demonstration of the connection. Throbbing of the heart, and extra systolic arrhythmia, which are recognised

§5. Palpitation.

§5. Palpitation.

symptoms of the attack, show that heart responds to central nervous participation.

There is a factor which is invariably present and is the agency which starts the seizure. It is no other than gastric flatus. Subjects of palpitation are gassy subjects. Hertz has shown by radio-graphic demonstration that the gassy stomach is a contractile stomach; contraction is set going when gas accumulates rapidly, and contraction of the gastric wall furnishes an appropriate stimulus to centres in afferent connection with the musculature of the stomach. Consequently segmentary centres under neurosis respond readily to the stimulus furnished by gastric spasm, and functions of heart, intercostal nerve and muscle are disturbed thereby. Recognition of these facts leads us towards rational methods of treatment. I have known patients who had been in the habit of taking a cupful of milk-food at supper, cured of night-seizures by leaving it off. A slop dietary, sweet and starchy foods, and tea, are often offenders. In certain cases five-drop doses of tinct. belladonna three times daily determines a cessation of attack. In other cases bromides of iron and arsenic give good results.

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Section 6. *Summary.*

SEIZURES of all members of the class of spasmodic disorders, including angina pectoris, are paroxysmal. {6.Summary.

They envisage morbidity of protective reflex function, the physiological purpose of which is expulsion of the contents of visceral tubes and cavities. All members of the class possess a common form of pathology, namely, segmentary neurosis. In all alike, visceral and parietal layers of muscle are scenes of tetanic spasm and rigidity. Tender spots are situated at terminals of spinal nerves, and pain is felt in distributary regions of sympathetic and spinal nerves. Cardio-motor and vaso-motor phenomena occur. Secretory disturbances attract attention, and unreasoning fear possesses the subject of attack. In all members of the class seizures are excited by physiological and psychological causes; disturbed emotions, sensory impressions, a vibratory medium, a cold atmosphere, intra-visceral tension and strenuous exertion.

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Part IV.

Diagnosis and Prognosis.

Chapter XII.

Diagnosis and Prognosis.

Section 1. *Diagnosis.*

§1. *Diagnosis.*

LOWER cervical and upper thoracic segments of the cord are proper seats of the anginous neurosis. The complete complement of the syndrome represents disordered activities of all functions centred in these segments.

In the case of Mrs. J. the seat of lodgment of the predisposing cause was well illustrated. Tender spots were found in their usual place of location, at points of outcrop of intercostal nerves. She could not lie on the left side or right, on account of tenderness of her arms, nor could she bear without suffering, any pressure exerted on them, intercostal and recti abdominis muscles were rigid. Hiccough indicated that the diaphragm was involved in the neurosis. At times she suffered from globus and dysphagia. The muscular tunic of the stomach was irritable and refractory against entertain-

ment of food or retention of gas. Vaso-motor phenomena were prominent. Blood pressure seldom fell below a reading of 200 mm. hydrag. Palpitation accompanied by tachycardiac displays, was no uncommon incident. Paroxysms of agonizing pain occurred in thoracic cervical and brachial regions, started by mental excitement, by disturbed emotion and by muscular exercise particularly that of walking. For days together and while the patient remained at rest in bed undisturbed by visits from friends or other agencies of mental excitement or emotion pain remained in complete abeyance. §1. Diagnosis.

At the necropsy conducted by Dr. Wingfield, pathologist of St. Thomas's Hospital, a secondary malignant growth was found involving coverings of the cord at lower cervical and upper thoracic segments penetrating to roots of spinal nerves in this region. The cortex of the cord itself was invaded by the new growth. The muscle of the heart was thick and robust. Valves and coronary arteries were free from disease. Aorta was elastic. Notwithstanding a most careful scrutiny it presented no lesion nor signs of atheromatous degeneration.

A syndrome of symptoms such as may appear when vicero-parietal centres of the cord in the region described are in a state of hyper-irritability is the mark of angina and a recognition of this fact leads to its diagnosis.

The angina pectoris is an instinctive protective phenomenon engineered by a viscus in distress. Nevertheless it can be excited,—as pointed out in the illustration given above,—by a central lesion. But this is rare. Another such case came under my notice a few years ago.

A man was tipping a sack of coal weighing two hundred weight. While he was hitching up the sack on his shoulders, just before shooting the contents into the coal hole, he felt a

§1.Diagnosis. sharp pain in the spine at or about the fifth or sixth vertebra, followed by cramp in the epigastric region and voluminous eruction of gas. Henceforward and until the day of his death some few months afterwards he suffered from veritable anginous seizures, belonging to the type recognised under the name of angina abdominus, the last of which killed him. It is suggested that coverings of the cord or the cord itself suffered lesion from strain. Unfortunately at the necropsy the spine was not examined.

Although a symptom or two of the complement may be missing, the syndrome is usually sufficiently characteristic to prevent the anginous seizure from being mistaken for any other form of paroxysmal attack.

The complement consists of discomfortable sensations of fulness or tension in intra-thoracic regions, often described by the patient as due to "a ball of wind at the heart," or "a lump in the gullet," attended by qualmy sensations at or behind the soft palate. Discomfortable pressure sensations beginning behind the lower end of the sternum, and spreading upwards to the level of the nipples on either side are also felt. Discomfortable sensations are ingravescent. They rapidly intensify and merge into pain, which usually occupies left or bilateral regions, between lower borders of second ribs and the horizontal nipple line, and may be felt also in one or both arms, in the neck and in the jaws, with all these is a sensation of fixation and tenderness of the thoracic walls.

The seizure is paroxysmal. It may start when mind and body are at rest, as in hours of night or early morning. It may awaken the patient from sleep. It comes on when the

subject of it walks, particularly when he walks uphill, and §1.Diagnosis. after eating, when he engages in exciting conversation or controversy ; when he is alarmed or startled ; when he stoops ; when he eats and when he goes to stool.

The patient suffers most from attacks when the atmosphere is cold and when he is exposed to boisterous winds. Seizures are frequently precipitated by a conjunction of events, such as walking on a cold day in face of a stormy wind, or joining in an exciting argument when at meals. Attacks come on when he walks upstairs, when he undresses in a cold bedroom, and when he climbs into bed and gets between cold sheets. The latter is a conjunction of events which is an acid test of the solidarity of the powers of resistance of the patient against seizures. The same may be said of subjective suggestions of impending defæcation, when the patient is distant from home, walking a draughty street on a bitter cold day. Anxiety to catch a train or to keep an appointment—indeed worry from whatsoever cause arising—hastens attacks which threaten subjects of them when walking.

If symptoms, causes of them and processes which excite them, above recited, are kept in mind, it is unlikely that difficulties will be experienced by the observer in differentiating seizures of the angina pectoris from all other forms of paroxysmal disorder.

Section 2. *Prognosis.*§2. *Prognosis.*

PROGNOSIS of the complaint is based upon the nature of its etiology and its complications. If the segmentary neurosis predisposing to seizures spring from functional disorder of the alimentary or uterine track, and if there be no serious nor progressive complicating disease, prognosis is good. So much can be said confidently so far as a fatal issue is concerned.

Is the segmentary neurosis itself progressive? The neurosis is a habit, and inasmuch as all habits gain a firmer hold on character, *pari passu* with their indulgence—so far anginous disease may be regarded as progressive. Conversely if the agency which sustains the angry temper of segmentary centres ceases to irritate; if unitary elements of the neuronie commune acquire stable constitutions and become stronger in powers of resistance against encroachment from irritative impressions, then the habit will decay.

It cannot be expected that any health will remain in the segmentary centres as long as dendritic processes of its neuronie population are trapped in a scar of contractile tissue, or are lying under pressure in the throbbing lair of an aneurism. Neither can it be supposed that lost virility will be regained while the pabulum of central neurons remains deoxidated

through disease or polluted through faulty metabolism or §2. Prognos
through disorganization of secretory function.

Consequently in presence of organic disease, from which unwholesome conditions such as these arise little hope can be entertained of recovery and hence the prognosis is bad.

Fortunately in the greater number of instances the predisposing cause of the seizure is sustained by functional disorder associated with the alimentary track. In such instances partial or complete recovery may confidently be expected, provided rational means be taken to secure this end.

But the habit, if firmly implanted, may continue operative for a considerable length of time after the cause from which it owes its being has been removed. A habit once inculcated can never be wholly eradicated. Agencies fostering recurrence may lie dormant and inoperative for months and years, again to appear under provocation from an unruly stomach. I know an instance of fatal recurrence after a dormancy of fourteen years duration.

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Part V. Treatment.

Chapter XIII.

On Methods of Treatment; Dietetic; Pharmacological and General.

- Section 1. Introductory.
- Section 2. Pseudo angina is a misnomer.
- Section 3. On diet.
- Section 4. On rest and exercise.
- Section 5. On tobacco.
- Section 6. On aperients.
- Section 7. On drugs in general.
- Section 8. On deflation of the stomach by mechanical means.

Section I. *Introductory.*

§1. Introductory.

CONSIDERATION of the classification and etiology of the angina pectoris suggests to us the requirements of a rational method of treatment. The angina pectoris belongs to the class of paroxysmal spasmodic disorders, associated with the musculature of the alimentary canal. It is an example of a neurosis involving segmentary

centres of reflex protective activities; normal functions of which, consist in the expulsion of various bodies from the alimentary tube. The *modus operandi* of the physiological reflex can be explained in a few words. Vagal excitability is evoked through the promise of satisfaction of appetite and peristalsis occurs. These activities are receptive. Conversely excitability of sympathetic centres is evoked through repletion, satiety and disgust, secretions become sticky, sphincters are active, peristalsis is hindered, and the food stream is held up. These activities are protective, they protect the duodenum and other portions of the canal from the admission of ill prepared and otherwise unsuitable food stuff. Exaggeration of reflex processes protecting the duodenum results in nausea retching eructation of gas and vomiting.

So far processes are physiological. A different tale is told when reflex centres are subjects of morbidity. Processes are then inco-ordinate. Tetanic spasms closing the orifices of the stomach are of frequent occurrence. Discomfortable sensations and pain are felt and gas which forms a medium of resistance is held up. Seizures resulting from tetanic spasm of the muscular tunic of the gastro-oesophageal portion of the alimentary canal are anginous.

Recognition of the cause of seizures evokes suggestions of rational methods of treatment. If intra-gastric pressure be kept at a low level, seizures are not readily excited. If hyper-irritability at segmentary centres be reduced, seizures are not sustained, and if imprisoned gas be released, they end.

But the problem of treatment is not as simple as it seems.

§1. Introductory.

Gas is the medium of high pressure. "The wind bloweth where it listeth and ye hear the sound thereof and canst not tell, whence it cometh or whither it goeth." In the case of normal subjects, high intra-gastric pressure provokes hyper-tonus of the muscular tunic. But in the case of anginous subjects on account of the presence of segmentary neurosis, hyper-tonus takes the form of tetanic spasm, anginous pain is felt, and continues to be felt until resistance is overcome and high intragastric pressure falls. Consequently to obtain relief from pain imprisoned flatus must be given vent, either through coronary or pyloric orifice. An alternative presents itself. Spasm ceases when central agencies no longer remain hyper-irritable. So the problem of treatment of the seizure is resolved into the question of release of gastric flatus or that of securing relaxation of spasm through central medication. Certain drugs have a dual effect. They produce central paresis and they also have a direct local influence upon muscular spasm. Methods of treatment of segmentary neurosis receive consideration in sections under distinctive headings.

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Section 2. *Pseudo Angina is a Misnomer.*

PERSONS presenting themselves with anginous symp- §2. Pseudo
toms should be taken seriously. The sooner the term angina is a
misnomer.

pseudo angina is forgotten, the better. The complaint is angina pectoris or it is not. If it be angina, the subject of it is liable to sudden death, no matter how negligible symptoms appear to be. It should be remembered that anginous symptoms, even in hysterical cases, are determined by a pathological basis of segmentary neurosis, and that neurosis when extending to cardiac centres, particularly if the heart be diseased, is a treacherous enemy. Many persons suffering from angina pectoris are dismissed with assurance that their complaint is not true angina, it is "only gastric," and therefore it need cause them no anxiety. How often do we hear that this has been told them.

In two such cases which came under my notice during early attacks, pain never rose above the nipple line, neither of them had cardiac or any other form of organic disease, yet both of them died suddenly; one of them just after hurrying home to escape a shower of rain. This patient had been under treatment four years before his death, and had left London to live on the east coast. In a letter informing me of his sudden death, his wife wrote:—

"He had not had any return of severe pain since leaving

London. A few days before his death he walked eight miles without feeling any discomfort. On the fatal day, after reaching home, he sat down in the dining-room without making any complaint. I left the room, and when I returned he was dead. He was still sitting on the same chair leaning back, and in the same pose as when I left him a few minutes before." In the second case death took the patient in his sleep. In the morning he was found cold. The night before his death he had eaten a heavy supper and went to bed on it.

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Section 3. *On Diet.*

§3. On diet.

IF we can cure chronic indigestion and its intestinal complications, we can also cure functional types of angina pectoris, that is to say, angina not based upon organic disease. Those of us who have had experience in the treatment of chronic dyspepsia will not be inclined to give a prognosis too favourable when confronted by cases of the angina pectoris, even at early stages of its course. But let not the student of the complaint be too far discouraged by this observation. Let him consider that nine out of ten cases of angina pectoris presenting themselves for treatment belong to the functional type and that in these, if appropriate means be devised, for the relief of intra-gastric and intra-colonic pressure, favourable results may be expected to follow. Many instances

in my own practice remind me that attention to dietary and §3. On diet. recourse to such drugs alone, as minister to healthy gastric and intestinal activity, have proved efficient in arresting the progress of the disorder, and in not a few instances have secured lasting immunity from seizures.

Recently, a gentleman practising medicine in a northern town, who had suffered from anginous seizures for four or five years, wrote to me saying that he had cured himself of the disorder through dietetic means alone. His chest had been examined by colleagues and others brought into consultation, who all alike had endorsed the opinion that mitral valvular murmurs which could be plainly heard on auscultation, constituted proof of the cardiac origin of the disorder. At first he gave way to what he then considered better opinion, and religiously followed a line of treatment laid down in express terms by his advisers. But things got worse rather than better; so he made a resolve and kept it. He abandoned "heart tonics;" drank a tumblerful of hot water every morning before breakfast; lived on plain mixed food; had his teeth put in order; took pains over mastication; and once or twice a week drank a wineglassful of apenta water an hour before the first meal of the day. Three months later in the letter to which I have referred, he writes:—"Rebellion against my doctor's orders has given me a new innings; 'I am now quite well': 'I have never suffered from a bad attack since I revolted'; 'On an average I walk six or seven miles a day and during visits on patients mount many stairs. The other day a friend examined my chest and pronounced my heart vigorous; first and second sounds are normal and destitute of murmur.'"

A doctor writes from the Midlands:—"Your article on the gastric origin of angina pectoris interests me, because it so exactly coincides with opinions I have formed on the subject

3. On diet. from my own personal experience. I have little or no tendency to arterio-sclerosis, but for some years past I have had occasional anginous attacks, which, in conformity with accepted pathology, I have attributed to cardiac degeneration, although I had no doubt about their gastric origin in flatus, as eructation always relieves the pain. But last year in the spring I had two attacks of such severity that I felt bound to call in the advice of medical friends, who in each case prescribed for me, and in each considered the case to be one of pure cardiac angina. In this diagnosis I for the time concurred, but on reviewing all the circumstances, I have now come to the conclusion that attacks are due to what, for want of a better name, I may call 'hepatic colic,' caused by congestion of the liver. On this view I have adopted the practice of stimulating the liver by a periodic dose of sodium sulphate, and for some months I have not been troubled with any attacks of angina worth speaking about, or which could not summarily be disposed of by eructation. Two of my medical friends who have lately examined my heart independently, assure me that it is sound."

Dr. W., practising in South London, writes:—"Have not yet had the courage to perform the tube trick"—a reference made to deflation of the stomach by introduction of an œsophageal tube—"As far as I can remember my attacks commenced about four years ago, and gradually increased up to two years ago, when, by constantly studying my diet, I was able to dodge them. Even now I find that after dinner at seven o'clock I cannot walk any distance without pain. Avoiding food from breakfast to that time, I can get on fairly well. There are several things taken at dinner which mean an attack in the night." Later, Dr. W. informed me that since he had acquired the habit of belching gas, when attacks were pending, seizures had become less frequent, less painful, and now gave him little or no anxiety.

Dr. X. writes :—

§3. On diet.

On 20th November, 1907, on account of the continual findings of high blood pressure, the consumption of animal food was reduced to small proportions. I lived chiefly for some months afterwards upon milk, eggs, vegetables, fruit and bread. On the date when this dietary was entered upon I weighed 14 stone 4 lbs. The regime with occasional variations was followed until the 23rd August, 1908. Weight had gradually increased after the abandonment of meat food and now reached 16 stone 2 lbs. Girth at the umbilical plane had increased from 42 inches to 54 inches. Instead of a collar of $16\frac{1}{2}$ inches in circumference I found it necessary to wear one of $18\frac{1}{2}$ inches and this was none too easy of fit.

Blood pressure during the regime fell from 165 mm. hydrarg to 145 mm. but when taking exercise I was subject still to ephemeral elevations of abnormally high range. Incidences of thoracic pain were excited more frequently than before and came into evidence before I had walked more than twenty or thirty yards. The dosage of nitroglycerine had been increased from one-hundredth to one-fiftieth of a grain and sometimes two or more tablets were necessary to stave off an impending attack. Moreover during the period of abstinence from meat, namely, in March, April and May, 1908, I had suffered from the series of definite anginal attacks to which reference has already been made.

On the 23rd August, 1908, the "milk-egg-vegetable" regime was abandoned and an "all meat" dietary adopted in its stead. This consisted of a category from which starch and sugar bearing foods were mostly eliminated. Vegetables, fruits, bread, milk, sugars, pastry, wines and fermented liquors were for the most part excluded. The day's rations were selected from a menu containing meat, poultry, game, fish, bacon and cheese, and to these articles were added a few slips of crisp dried toast with an occasional tomato, orange,

. On diet. lemon or dish of spinach. The beverages taken with meals were weak tea, lemon water or whiskey freely diluted with Malvern, Seltzer or Apollinaris water.

Ten days after the adoption of this regime I noticed a remarkable improvement in my general health. I had lost between eight and nine pounds in weight. Flatulence ceased to be a prominent symptom. Incidences of thoracic pain were less frequent. I found myself able to walk 150 or 200 yards without discomfort. Moreover blood pressure had fallen 10 mm. hydrarg. and ephemeral elevations during exercise did not exceed 170 mm. hydrarg.

Decline in weight under the "all meat" dietary is illustrated in the figures of the following table:—

1908.	st.	lb.	st.	lb.	st.	lb.
Aug. 23rd	16	2	Sept. 6th	15 $4\frac{1}{4}$	Sept. 19th	14 11
„ 24th	16	1	„ 7th	15 $3\frac{3}{8}$	„ 20th	14 10
„ 25th	16	$0\frac{1}{4}$	„ 8th	15 $2\frac{1}{8}$	„ 21st	14 $9\frac{1}{2}$
„ 26th	15	$13\frac{1}{4}$	„ 9th	15 $1\frac{3}{8}$	„ 22nd	14 $8\frac{3}{4}$
„ 27th	15	$11\frac{5}{8}$	„ 10th	15 $1\frac{3}{8}$	„ 23rd	14 $8\frac{1}{4}$
„ 28th	15	$10\frac{1}{4}$	„ 11th	15 1	„ 25th	14 $7\frac{3}{4}$
„ 29th	15	9	„ 12th	15 $0\frac{3}{8}$	„ 26th	14 $7\frac{1}{8}$
„ 30th	15	$8\frac{3}{8}$	„ 13th	15 $0\frac{3}{8}$	„ 27th	14 7
„ 31st	15	$8\frac{1}{4}$	„ 14th	14 13	„ 28th	14 $7\frac{1}{8}$
Sept. 1st	15	8	„ 16th	14 $13\frac{1}{2}$	„ 29th	14 $6\frac{3}{8}$
„ 2nd	15	$7\frac{1}{8}$	„ 17th	14 $12\frac{1}{8}$	„ 30th	14 $5\frac{1}{4}$
„ 3rd	15	$5\frac{1}{4}$	„ 18th	14 $11\frac{3}{4}$	Oct. 2nd	14 $4\frac{5}{8}$

On the 22nd October, 1908, my weight having fallen to 14 stone 1 lb. I found myself able to walk a distance of two miles without pain. On the 1st November I weighed 14 stone $2\frac{1}{4}$ lbs.; on the 1st December 13 stone $12\frac{1}{4}$ lbs.; on the 1st January, 1909, 13 stone $11\frac{5}{8}$. The lowest weight reached under the all meat regime was on the 2nd May, 1909, when it had declined to 13 stone $6\frac{1}{8}$ lbs.

After this date severe restrictions upon dietary were

suspended and excluded articles were admitted in sparing §3. On diet. quantities. Blood pressure registered 130 mm. hydrarg. Ephemeral elevations during exercise range within normal limits. Since the abandonment of the milk, egg, vegetable regime waist girth has decreased by 13 inches and collar measurement by 2 inches.

Later attacks recurred with some show of violence, and Dr. X. then made some experiments on the effects of dietary upon frequency and severity of seizures. He used to dine during term at Middle Temple Hall, and after dinner he was accustomed to walk up Middle Temple Lane to the Strand, and hence to Victoria Station. The experiment consisted in taking for five or six days in succession a plain meal without wine or ale, and without sweets, and for an equal period following, to indulge in the forbidden dishes and drinks, and to note results. To confirm the correctness of his conclusions, experiments were repeated many times in succession. He observed, that when he took the plain meal he could walk to the station without occurrence of seizures. Conversely, when he indulged in forbidden dishes and wines, seizures occurred, even before he had reached the end of Middle Temple Lane, which slopes uphill towards the Strand.

Digestion is improved and the severity of seizures mitigated by attention directed to mastication. In several anginous subjects I have known symptoms become less prominent after faulty teeth had been removed and replaced by an artificial set.

In the early days of my experience in the treatment of angina, I put patients coming to me on milk diet, after the

§3. On diet. method of practice recommended at the schools : four or five pints being sometimes taken in the day. The effect was not good : in certain cases it was harmful, attacks came on frequently and with great severity. I soon abandoned the practice. I find these views on the dangers of the milk diet are endorsed by Sir Clifford Allbut, on page 526, v. 2, *Diseases of Arteries*, he writes :—

“ If resorted to for a short time only and together with strict bodily rest, it may be efficacious,” but he adds, “ In the many cases of puffy, big-bellied persons with flabby hearts I should regard it as an unfit, and even a perilous method.” “ With the *propter hoc* I will not meddle. The precautions in respect of the digestion are to be sedulously imposed and noted, for indeed a windy stomach, if not a primary cause of angina, may suffice to part the slender thread of life.”

I have tried the lactic acid bacillus method of treatment in several cases without noting any good results. Miss E. had milk prepared after this method and took it for thirteen or fourteen days in succession. But it proved a failure. During the period of its administration and for several days afterwards, attacks which had been reduced to almost total abeyance, sprang again into activity. Happily, after its injurious influence was removed, they rapidly declined in severity and frequency.

A lady living in a provincial town was seized while dressing in the morning with a distressing sensation which soon merged into pain ; involving back, shoulders, neck, and arms. It recurred again and again. It was brought on by going upstairs and by walking in the road. Attacks awoke her from sleep. Seizures, although not severe, caused her alarm ; she interpreted them as warnings of sudden death. Notwithstanding a most careful examination, I was unable to

detect any organic disease. Although she did not complain of §3. On diet. discomfort after eating, gastric resonance was high; reaching to the lower border of the fifth rib. She was put upon a strict diet, and half teaspoonful doses of glycerine of pepsin were prescribed. After following instructions for one month, she wrote:—"I am now able to walk considerable distances and do my own shopping in the town. Night and day attacks have ceased." Two years later she informed me she had no recurrence of seizures.

Mr. C., for several years had been subject to anginous seizures. Lately, attacks had been excited more readily than formerly, and during the past few months he had seldom been able to walk more than 100 or 150 yards on level ground without the provocation of a seizure.

He commenced a course of treatment at Ramsgate on July 5th, 1911. It consisted of frequent draughts of cold water taken before or between meals, namely, a tumblerful of cold water early in the morning while dressing, followed by gentle exercise in the open air; a second was taken two hours after breakfast; a third two hours after luncheon; finally, a tumblerful was drunk at bedtime.

No drugs were taken during the course, with the exception of a few rhubarb tabloids in the evening, twice a week, and a wineglassful of apenta water before breakfast once a week.

The dietary chiefly consisted of plain, tender, cooked meat, and green vegetables. The patient abstained from wines, milk and milk foods, eggs, potatoes, bread—except in scanty quantity—and sweets.

§3. On diet.

He smoked a mild tobacco with moderation, and drank a glassful of whiskey and apollinaris in the evening. The four o'clock tea meal was passed. He rose at six in the morning, took a cold bath, sauntered about all day in the open air, and went to bed at eleven p.m.

Seven days after this course of treatment was begun, the patient wrote informing me that he was able to walk several miles without experiencing a seizure, and that he was satisfied he could walk further but for weakness of his limbs, which were somewhat out of condition from long disuse.

On July 19th he again wrote informing me that he had followed precisely the line of treatment laid down for a further seven days, and that on the morning of the 19th he had walked four miles before breakfast, encountering steep hills, finally climbing a flight of ninety-two steps leading from the harbour to the cliff parade, this without feeling any thoracic discomfort or pain.

On September 5th, Dr. X. made experiments on effects of tea taking, upon the gassy symptom, and upon the frequency of seizures. For a fortnight previously the gassy symptom has been prominent, and frequency of seizures correspondingly marked. So tea was excluded from the dietary list. Before tea was excluded, sensations of fulness at the chest and desire to eructate, came on about one-and-a-half to two hours after breakfast, and walking across the room was usually attended by uncomfortable sensations at the chest. Exclusion of tea from breakfast and replacement of this drink by Van Houten's Rova cocoa, was attended by favourable results.

A schema of dietary which commends itself as suitable, ^{§3. On diet.} but subject to variation as occasion may require, consists of a breakfast made from a large cupful of pure but weak cocoa, free from sugar or flavouring agency; such, for instance, as Van Houten's Rova Brand, taken without milk, and a plate of bread and butter or dry toast, plentifully buttered. At luncheon hour, say one o'clock, a fresh grilled sole with bread or diabetic biscuits, makes a good meal. At 4.30 p.m., tea should give place to cocoa or coffee. Dinner at seven is late enough, and here a small quantity of butcher's meat or game with vegetables in season may be taken. Soups, sweets, wine, and malt liquors are banned. Strong tea and coffee are followed by disturbing effects. Late in the evening, if the patient be accustomed to alcoholic drinks, a glass of whiskey and water is calculated to promote sleep. Mineral waters should not be taken, except on occasion. This scheme of dietary must not be regarded as a rigid one, it is merely a suggestion. Patients usually know what agrees with them best, and much should be left to individual choice. There is no objection which can reasonably be opposed to moderate smoking of mild pipe tobacco. Lambert and Butler's sun-dried honey dew is among the best; since, from this tobacco, tars have been extracted.

In cases in which anginous pain comes on during food taking and after stool, a remedy much favoured by custom, has been found by me to act quickly and efficiently. In each of these instances gastric reflex spasm is the cause of pain. This conclusion is reached, because, in both instances, pain is

§3. On diet. relieved by eructation of flatus. The remedy suggested is a tablespoonful of brandy or whiskey taken in hot water. Almost immediately after it is swallowed, gas is thrown from the chest, and pain passes away with it.

This remedy is sovereign in abolishing that symptom which in Lancashire dialect is fittingly described under the name of "nesh." It is a general inward sensation of coldness, which is not removed by additional clothing however thick the garment be. It gives the impression of a stream of cold water running down the back. Cold waves from the spinal column sweep forward to the mid axillary vertical line involving chest and abdomen. It is a diffused sympathetic sensation, described more fully in the chapter on pain. The anginous subject frequently feels "nesh" when taking a meal or soon after it is eaten. The sensation may be unattended by pain.

A post-digestion acid state of the stomach promotes duodeno-caval reflexes and closure of the pyloric orifice. It also encourages stasis in the intestinal track. Ten grains of bicarbonate of soda taken at bedtime in half a tumblerful of cold water relieves gastric acidity, and if the practice be followed when hyper-acidity exists, tends towards the reduction of chronic abdominal tension.

The chief aim of treatment is to keep down intra-gastric and intra-intestinal pressure to small proportions. Although gas is the medium of pressure, the quantity of residual gas present is a subject of secondary importance only; whereas

conditions of gastro-intestinal muscular tunics and segmentary centres innervating them are things which really do matter. ^{3. On diet.}

For instance, on account of gathering accumulation of gas, a person seated at table after dinner may find it necessary to unbutton waistcoat or belt to give play for the swelling belly. This done, no subjective sensations are felt reminding him of gaseous distension. But if he get excited in argument, if he get up from table and walk, particularly if he go upstairs, subjective sensations are aggressive, and the desire to expel gas comes into being. Subjective calls to retch or to eructate, result from muscle sense impressions emanating from hypertonus of muscular tunics of the stomach. Usually these sensations are discomfortable only, they are felt in thoracic regions, not infrequently behind the synchondrosis. Often they are attended by cardiac irregularity. When segmentary centres are hyper-irritable, symptoms are exaggerated, gastric hypertonus is translated to spasm, and discomfortable sensations merge into pain. The attack is then called anginous. The gaseous stomach is a stomach of excessive contractile activities, that is to say the bismuth meal is passed into the duodenum after an abnormally short period of entertainment in the stomach. Certain kinds of food provoke early expulsion through the pyloric orifice, and dietary having this effect should be avoided.

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Section 4. *On Rest and Exercise.*

§4. Rest and exercise.

WHEN attacks are frequent and severe, rest in bed is necessary. Indeed the patient can do no other ; for muscular effort—even turning over or shifting position—is followed by thoracic pain. While acute segmentary neurosis lasts, the quieter the patient keeps himself the sooner will his symptoms subside. He should not be permitted to tax his mind with matters requiring deep thought. Controversial subjects of conversation, by those permitted to see him, are inadmissible.

Much importance attaches to the recommendation of an hour's rest before and after meals. When the lower loop of the ileum is engorged with fœces, traction is exerted upon the upper end of the jejunum at its junction with duodenum, and the curve at the duodeno-jejunal flexure becoming acute, obstructs the outlet of the duodenum. During the recumbent pose the outlet of the duodenum becomes again patent and food is allowed to pass through freely. Spasm at the cavum as I have already described is encouraged by a full duodenum. It is a protective duodeno-gastric reflex action. This cause of anginous spasm is less likely to be operative when the patient rests before and during digestion.

In subacute segmentary neurosis improvement follows the practice of taking an hour's rest after meals. It is important

that the pose of the body be horizontal, or better still that the hips be raised above the level of the shoulders. In persons of the anginous habit it has been observed that gasses and food stuffs are retained in the duodenum for an undue space of time owing to obstruction occurring at the outlet of the channel. The relationship of the distal end of the duodenum with the root of the mesentary favours occlusion. Here the gut lies in the triangular space below the attachment of the mesentary to deeper structures, and here it is subject to pressure when intestines are heavy with undischarged matter. Assumption of the horizontal pose relieves tension at the point of pressure and secures more rapid discharge of peptones from the stomach. For be it remembered that a full duodenum excites protective reflex action which closes the pyloric orifice. Moreover, distension of the duodenum tends to perpetuate itself by prevention of a free flow of bile and pancreatic juice.

Dr. X. has proved by repeated experiments that malt liquors and pastry, puddings and other such foods, taken at meals add to frequency and severity of seizures. Effects of indulgence in these articles was not noticeable while he still remained at table and not much so on those occasions when he rose from the table and walked immediately after the meal was ended, but when he lingered at table for half an hour or so, and then set out to walk, early attacks were invariably induced, and attacks thus induced were severe. He also noticed that the meal digested more rapidly and seizures did not threaten as readily when he rested in the horizontal

§4. Rest and diet.

position on the couch for an hour after food taking, or for a longer time if the meal were large.

It is desirable to rest for an hour after defœcation, especially when the action has been induced through aperientation, since after defœcation seizures are more readily excited than at other times.

During the sub-acute or chronic phase, regular exercise in the open air must be taken, even when walking is laborious and distasteful. If pain be felt during the walk, the patient should halt and rest until the seizure no longer threatens. After a few minutes rest, walking can be resumed. It is usually found that when exercise is persevered in, capacity for exercise grows, and, during walking, gas is frequently painlessly expelled from the stomach. Heberden ascribes the cure of one of his patients to the practice of sawing wood. Undoubtedly, a sedentary life encourages accumulations of gas in stomach and intestines and fosters gastro-intestinal high tension, a condition which provokes seizures. Whether active exercise should be taken or not in cases in which organic disease is the basis of the anginous habit is a matter for determination on the merits of individual cases.

Notwithstanding its remedied value, walking exercise at the moment increases abdominal tension, and consequently raises intra-gastric and œsophageal pressure. The mechanism, through the agency of which this transmission of energy is effected, was explained in a previous

chapter.* Through this agency, seizures are excited in subjects liable to them, whensoever walking distances is practised. The same results do not follow cycling, for during this form of exercise abdominal walls are relaxed, and abdominal tension remains low. Dr. X., who could not walk eighty yards without provoking a seizure, could cycle eight or ten miles without feeling any thoracic pain. In early stages of angina pectoris, through practice of this exercise for a few hours a day, the anginous subject continues healthy, hard, and fit. Whereas in the case of the healthy adult walking, raises blood pressure until readings show an advance of about 30 mm. hydrarg., yet the same person can cycle for the same period of time without advancing blood pressure by a single degree. For this reason there is no better exercise for cardiac disease than cycling. When the patient is not sufficiently strong to take outdoor exercise, massage and passive exercise should be regularly employed to keep his muscles in good tone and his skin healthy. The skin may be kept in good secretive order by an occasional vapour bath, which is well borne by the anginous subject.

§4. Rest and exercise.

* The abdominal cavity is a muscular sac formed above by the diaphragm, below by the perineum and at front and sides by abdominal walls. During walking crura of diaphragm are retracted, its aponeurosis moves on a lower plane, perineum is raised and muscle of the abdominal wall is hypertonic. So during walking intestine and stomach enclosed in this sac are subjected to high pressure and gas residual in the stomach is forced through the coronary orifice into the œsophagus, raising intra œsophageal pressure and exciting anginous pain.

The self-same mechanism which excites anginous pain assists circulation of the blood stream. Through retraction of its cruræ the diaphragm is constrained to conduct respiratory movements on a lower plane. Intra thoracic minus pressure is thus raised. Auricles suffer distension, and a venous stream drawn from systemic, abdominal, thoracic and pulmonary tributaries, fills the chambers of the heart. Consequently we agree with the words of Sir Clifford Allbutt when he says, "Dyspnœa, be it ever so sudden, so violent, or so suffocative, is no essential symptom of agina." —Diseases of Arteries, Vol. 2, p. 317.

§4. Rest and exercise.

There are some who hold that rest in bed and relinquishment of business or professional pursuits are among essentials of successful treatment. Except in acute cases, where the patient must rest, my experience leads me to take a contrary view. Ideal conditions consist in residence in pure mild yet bracing air, on chalk, gravel, or sandy sub-soil, at a moderate altitude, and under protection from easterly and northerly winds by cliff or rising ground. Even in instances in which exercise is irksome, the morning walk should be taken regularly during all seasons when weather permits.

Almost immediately after setting out to walk, Dr. X. is beset with uncomfortable sensations at the chest, feelings of lassitude, dull aching in the loins and limbs, and general slackness of physical energy. But after he has struggled against these discouraging symptoms, and stopped numerous times to gain ease from oppression and pain gathering at the chest, and after gas in quantity has been eructated, he finds himself better able to proceed forwards, and now first begins to find pleasure in the walk. Through this self imposed ordinance passed morning after morning, Dr. X. succeeds in securing comfort for the latter part of the day. If the walk be omitted, the chest remains burdened with gas, and discomfortable sensations trouble him until bedtime. Dr. X. reports that on occasion when he has been obliged to remain indoors for several days on account of severe weather, his first day out of doors has proved an uncomfortable experience, owing to pressure of gas at the chest.

An attendant with a bath chair should at first be

requisitioned to accompany the patient on his walk, so that he shall be furnished with means of taking rest when and as often as he will. As soon as discomfortable sensations of pressure at the chest come on, the patient halts and leans on the back of the chair for support, awaiting the passing of the sensation; an event which is frequently attended by escape of imprisoned gas from the chest. If when pressure is felt the patient is walking, flatus is not as readily expelled. It comes off more easily when he is in a restful pose. Persons who have acquired the art of gaining relief from oppression at the chest by belching gas, usually find as the walk proceeds, attacks occur less frequently. After several voluminous explosions have unburdened the chest, considerable distances can be covered by the patient without the provocation of thoracic discomfortable sensations, and the rest of the day is passed with more comfort.

§4. Rest and exercise.

Brighton offers more favourable opportunities for the daily routine of treatment of persons of the anginous habit than other health resorts near London. The air is pure and bracing, yet not too strong. At all seasons of the year, with few exceptions, regular exercise can be taken on the sheltered Madeira Drive. At King's Cliff, just above the Drive, and connected with it by a lift, several hotels are situated outside the burly of traffic of the town. At certain of these quiet and roomy establishments radiators are installed securing equable temperature of passages and rooms. Moreover the district is well provided with houses let in private

§4. Rest and exercise.

apartments suitable for the accommodation of persons who prefer greater privacy than a hotel affords.

Exposure to a cold atmosphere, especially during exercise, results in frequency and severity of seizures: in a variable climatic regularity of exercise can alone be secured by residence at a suitable place.

It is said by certain authorities on angina pectoris that the patient should refrain from doing anything to bring on seizures, because, say they, every attack suffered increases the paroxysmal tendency. There is truth in this reason, but on the other hand there is danger in following the advice too closely, for if in obedience to it, exercise be abandoned, those ills inseparable from a sedentary life surely gather until they threaten life. Even if seizures be evoked by exercise, as usually they are, the patient should not be deterred by his suffering from the practise, for through persistence in it, the paroxysmal tendency is at length reduced. Time and time again I have noticed the beneficial results derived from regular walking. On going out, anginous subjects, who for long have been coddled in doors, find difficulty in walking a dozen yards, and even their first steps are embarrassed by abdominal and thoracic uneasiness. Discomfort is augmented by nausea and a desire to eructate gas. When gas is thrown from the chest a measure of relief follows, and a further advance is made. If patients bear these initial discomforts and after repeated adverse experiences, still persist in walking, the reward earned by perseverance is not denied them, and they find that the walk can be continued for a considerable

distance in comparative comfort. It should ever be remembered that thoracic discomfort induced by walking, subsides when walking ceases, and that gas flows more readily from the chest during a halt than while the walk is in progress. A stanza from the Faery Queene may well be kept in mind.

“ And as she looked about she did espye,
 How over that same door was likewise writ :
 Be bold, be bold, and everywhere be bold.
 That much she mused, yet could not construe it,
 By any riddling skill or common wit ;
 At last she spyed at that room’s upper end,
 Another iron door on which was writ :
 Be not too bold.”

* * *

Section 5. *On Tobacco.*

DURING late years the tobacco habit has grown. §5. On tobacco.
 The proportion of smokers in the male population has increased and on account of higher wages among the working classes the consumption of tobacco per head is much larger than it used to be. Women who formerly would have none of it now smoke in the afternoon and evening and some of them light a cigarette after breakfast. If tobacco poisoning be a fruitful source of the angina pectoris we might expect to find an indication in the death rolls of the kingdom. But I

§5. On
tobacco.

am not aware that any deduction of the kind can be drawn from the Registrar General's returns.

For the last thirty years I have been on the look out for examples among a well to do population of brain workers who as a class are more prone to the complaint than handicraftsmen, but I have not found a single incontestible instance. About fifteen years ago a gentleman suffering from seizures of a severe form which threatened life presented himself for treatment. He smoked habitually about one ounce of tobacco of medium strength daily. When asked to abstain from smoking he retorted saying he would rather die of the complaint than live without tobacco. He ate and drank freely but although inflexible in the matter of giving up smoking, he was amenable to advice in the matter of excess. He was induced to smoke only in moderation, to abstain from alcohol and to reduce consumption of food. When high intragastric and intra-abdominal pressure had been reduced through strict observance of dietetic rules and through the administration of appropriate aperients, an improvement set in, characterised by reduction in frequency and severity of seizures. As time went on, although smoking was continued, attacks became less frequent and severe. At the end of four month's treatment they ceased altogether. Recently a friend of this patient told me that he was in excellent health and still as ever, devoted to his pipe.

For the last thirteen years Dr. X. has been subject of the anginous habit and except during seasons when attacks have been frequent and severe, has continued the habit of

moderate smoking. In severe cases persons lose taste for alcohol and food. Tobacco adds to feelings of nausea ; a common symptom among anginous subjects. Often during these periods the pipe is put voluntarily on the shelf.

When smoking produces nausea or aggravates it an increase of frequency of seizures and severity of pain must be expected from it. But fatality cannot be measured in terms of the pain index. Tobacco in excess causes extra systolic arrhythmia ; a form of arrhythmia often already present in anginous subjects. This trope must be contra-distinguished from those prolonged pauses in rhythm to which attention had been called by Sir Clifford Allbutt. The one is a protective expedient against inhibition, engineered by the sympathetic system ; the other a long outdrawn diastole of evil import, the work of an angry vagus.

A sudden arrest of the habit of smoking is not altogether a harmless proceeding. Young athletes in training for rowing, suddenly deprived of their tobacco, sometimes develop signs of high central hyper-irritability and disturbed cardiac action lasting for many days afterwards. I understand the practice of smoking light tobacco in moderate quantity is now allowed by trainers, and adoption of the less severe rule is justified by results.

An increase of irritability at vagal centres is dangerous to the anginous subject, and when it is found that the sudden stoppage of tobacco produces this effect on healthy persons, there is reason to reconsider the practice universally prevalent of banning tobacco altogether in the case of anginous subjects.

\$5. On
tobacco.

In practise I have not noticed any harmful effect follow from moderate smoking of mild tobacco.

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Section 6. *On Aperients.*

§6. On
aperients.

IN the treatment of persons of the anginous habit, a proper method of aperientation holds a prominent place.

Anginous seizures are initiated and sustained through high intra-gastric and high intra-intestinal pressure, and their end is determined through liberation of imprisoned gas. Sustained high intra-gastric and intra-intestinal pressure or irritation are among the chief causes of that form of segmentary neurosis which predisposes to anginous seizures and constitutes the basis of the anginous habit. For this reason the first measure taken to overcome the disorder and eradicate it, should be directed towards the discovery of a method, whereby functional activities of the alimentary canal shall be conducted after an orderly manner without disturbance through intratubal high pressure. Hence the importance of adopting, at the threshold of treatment, a proper method of aperientation which can be continued indefinitely without hurtful consequences.

Many persons of anginous habit enjoy regularity of action, others not so; but, whether action be regular or not, the need

for aperientation is not the less to be taken into account. ^{\$6. Or}
Regular action too frequently masks a gas-laden colon, which
never efficiently empties itself, and which, in certain instances,
contains a large quantity of residual matter. The plombiere
douche frequently reveals the presence of unsuspected ac-
cumulations of fæculent matter. The containing capacity
of the colon is very large. A flat abdominal wall may hide
an intestine brimful and disorderly. The true situation
is often recognised for the first time when ocular evidence
is given by the volume discharged after an efficient aperient
has been taken. So narrow-gutted and pot-bellied persons
of regular and irregular action alike are fit subjects of treat-
ment by aperientation.

Aperients which rely for efficiency upon central nervous
stimulation, or intensive local irritative properties, are
unsuitable agencies for habitual usage. Selection should
rather be made from drugs given with large volumes of water,
which filling a section of the tube through which they are
passing, carry along with them fermenting, decaying, and
undigested matter, and drive before them, gusts of residual
flatus. Such a remedy, suitable in most cases, is found in
sulphate of sodium, in conjunction with the bicarbonate of the
same mineral dissolved in a tumblerful of hot water and
taken at early morning on an empty stomach, one to two
hours before the first meal. A heaped teaspoonful of the salt
with fifteen grains of bicarbonate of soda is the usual dosage,
but quantities can be varied with advantage to suit particular
cases and instances. Occasionally in the event of alkaline

§6. On
aperients.

secretions, the bicarbonate of sodium must be withheld for a time.

The practise of taking ten grains of sodium bicarbonate, dissolved in a tumblerful of cold water at bedtime, is often followed by a considerable reduction in abdominal tension.

Sensations of weariness, malaise, loss of energy, back-aching, and leg-aching, are not infrequently complained of by patients under this method of aperientation. These symptoms should not be regarded as effects of lowering properties of the salt, but rather as indications of insufficiency of dose. After complaints of this character when the quantity of sodium sulphate has been doubled or trebled at the next morning's exhibition I have noticed the disappearance of the symptoms mentioned.

An old friend, now seventy-five years of age, was advised to relinquish practice thirty years ago on account of frequent and severe seizures of angina pectoris, which he was assured resulted from cardiac disability. Instead, he took a month's rest and practised this method of aperientation. At the end of the month, frequency and severity of seizures had been so far reduced that he found himself able to recommence work again, and did good work for twenty-five years afterwards. A few months ago he informed me that he could walk distances of six or eight miles during the day without feeling fatigue, and that he never felt better, nor had a better appetite in all his life. Ever since, with the exception of occasional breaks, he had continued taking the early morning dose. Seizures left him, never to recur, two years after the day on

which he had adopted the practice. This is the clinical history of one out of a number of cases of similar kind coming under my own personal notice extending over a number of years, during which experience has justified the value of this method of aperientation. §6. On aperients.

Doctor X. takes the salt three or four times a week, and has done so continually, with great advantage, for several years. Occasionally he adds 15 grains of sodium bicarbonate to the dose. The practice of filling a Thermos flask with boiling water at night and keeping it on a table by the bedside with an empty tumbler and the salts ready for use, encourages regularity in administration.

For a time, Dr. X. was deterred from taking the salt, on account of œdema of the lower extremities, which followed its administration. The difficulty was at length overcome by the exhibition by small doses of thyroid colloid and glycerine of pepsin.

When persons suffering from anginus pain are affected by œdema of the lower extremities, whether after taking the salt or without it, they find a good remedy in minute doses, say the tenth of a grain of thyroid colloid. The amount of urinary secretion is largely increased and puffiness leaves the eyelids and brows. Large doses are not well borne. When unsuitably large doses are taken, extra systoles are apt to break even rhythm of the pulse, and anginous pain is increased.

Thyroid colloid acts upon involuntary muscular fibre. It causes contraction of the dartos muscle and narrows the

§6. On
aperients.

urethral stream. It is inferred that reduction of œdems is affected through increased tonus of involuntary muscle which acts as an automatic splint and supports walls of capillary vessels traversing it. It is also inferred that increase of anginous pain attending administration of large doses of this gland, is attributable to intensive hypertonus of gastric muscle; proof in favour of this latter inference is found in augmented eructative phenomena.

In a number of cases I have employed with advantage an aloes and belladonna pill taken in conjunction with the sulphate of sodium dose. One grain of Barbadoes aloes combined with one quarter grain of green extract of belladonna is a convenient formula. Certain persons under treatment, one a medical practitioner, have told me that they prefer Beecham's pill to the formula recommended, they say its action is more efficient and I think they are right. I understand that the active ingredient in Beecham's pill is aloes. The aperient dose should be taken early in the morning and one, two or three hours before the first meal. It is my usual practice to direct the patient to take the aloes pill at night on going to bed and the salts early in the morning. This method of aperientation may be followed every second or third day. A good action usually occurs half an hour after breakfast. If the action lags, a walk hastens it.

On the subject of aperientation, Sir Clifford Allbutt writes:—"All physicians of experience warn us in angina against a loaded colon and recommend mercurial occasionally and podophylin more frequently in small doses say one tenth

of a grain three times a day." While paying full respect to this great authority in angina pectoris, experience warns me that frequent aperientation leads to spasmodic conditions of the intestines, and that in most cases coming under my notice better results are obtained by allowing intervals of one or two days duration to intervene between doses than by more frequent aperientation.

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Section 7. *On Drugs in General.*

HYPER-IRRITABILITY at segmentary and §7. On drugs in general.
 vagus centres is reduced by administration of drugs which benumb peripheral nerve endings and thus afford rest to the harrassed central nervous system. Ranking high among these is belladonna. This drug should be taken in five drop doses, half-an-hour before meals. In certain cases its administration is followed by immediate improvement, and continued administration effects a cure. In certain instances, immediate results are good, but improvement beyond a moderate measure is not affected, and retrogression follows, again, in other instances, not few in number, no improvement occurs, indeed, symptoms are aggravated. Really good results are more often obtained in women than in men, and rather, in those cases in which hyper-æsthesia at points of outcrop of

§7. On drugs
in general.

intercostal nerves is a prominent feature, than those in which this symptom is not very manifest. In the former variety of cases, one of the earliest signs of improvement is detected in a reduced number of tender spots, and the number wanes as improvement advances. In the case of Miss F., referred to at length in chapter X., p. 166, in which belladonna effected a cure after several years of illness, when all other remedies had failed, immediate improvement in the hyper-algesic symptom was marked, and a fortnight after the administration of the drug was begun, the patient showed herself to be on the high road to recovery. This lady had complained much of qualmishness, worse, sometimes than others, but rarely entirely absent. She also had spoken of frequently recurring attacks of heartburn. Under treatment with belladonna, both these symptoms vanished.

Here a warning note is necessary. Belladonna administrations were abandoned in the case of an old lady of anginous habit on account of the bad effect of the drug on the eyes. She had suffered from glaucoma for several years. Soon after she began a course of belladonna she complained of annoyance from frequently recurring flashes of light before her eyes, as this symptom continued and tended to grow worse rather than to improve, and as her eyesight, which was none too good, showed signs of further limitation she was advised to give up taking the drug. After discontinuance of belladonna, this symptom was no longer noticed.

Iodide of potassium easily takes chief place as a remedy in the treatment of the segmentary neurosis, in all kinds of

spasmodic complaint associated with the musculature of the alimentary canal, among which the angina pectoris is a prominent example. The drug is best administered in ten or fifteen grain doses, dissolved in half a tumblerful of cold water two hours after meals three times a day. If iodism appear, a single dose of twenty grains in place of the usual ten grain dose should be given. Doses of less than ten grains do more harm than good. If doses of ten grains fail to relieve symptoms, fifteen or twenty grains may be taken with advantage, and be continued for a week or more together. Intolerance of the drug is manifested frequently in anginous subjects; more frequently than in most other types of complaint. Taken in conjunction with aperientation by sulphate of sodium in accordance with the method of administration of this drug, described in the last section, patients otherwise intolerant, frequently become tolerant. Tolerance is acquired sometimes by a visit to the east coast, or to other bracing atmosphere. Sometimes, however, all attempts to prevent iodism are fruitless. In certain cases under my notice, including that of Miss F., attempts to establish tolerance failed. About twenty-four hours after the course was begun, jaundice and other catarrhal symptoms appeared, and persistence in the treatment caused increase in frequency and severity of seizures. The same parlous manifestations occurred whensoever further attempts were made to habituate the patient to the drug, so its administration was abandoned.

In the case of Dr. X., attacks vanished under treatment with iodide of potassium. During intervals of months

§7. On drugs
in general.

§7. On drugs
in general.

together, no symptoms were noticed. But seizures always returned again. Their reappearance at one time was attributed to one cause, and at another time to another cause. At length Dr. X. became intolerant of the iodides, and intolerance remained for several years. The patient, however, regained tolerance while on a visit to the coast. At the present time Dr. X. finds himself able to take iodides when occasion requires, but although they mitigate the severity of symptoms, still, upon the output of strenuous effort, paroxysms occur.

In the case of a New Zealand colonist who contracted the complaint while in this country, and who was unable to return home on account of frequency and severity of attacks, iodide of potassium taken alone in doses of twenty grains failed to establish pronounced benefit. But after a course in which this drug was combined with belladonna, attacks ceased, and he found himself able to return to the colony. Thence he wrote after three months residence saying that seizures had not recurred.

Insomnia, which frequently troubles the anginous subject, can be relieved and often cured through daily administration of 10 grain doses of iodide of potassium. "Solurool," a product put up in tubular form by Messrs. Allen & Allenbury was found effective by Dr. X. in reducing frequency and severity of seizures. It is claimed to be a remedy for gout. It is said to secure rapid elimination of uric acid. Administered alone Dr. X. did not find its action as efficient as when taken in conjunction with morning or second morning doses of sodium sulphate and with aloes pill and sodium bicarbonate at

night. With this combined treatment the secretion of urine, previously scant, was doubled, and brick dust deposit ceased to stain white earthenware of the receptacle. Digestion and appetite improved, and flatulence lessened. Oedema of shin, ankle and feet, which had become a chronic feature, vanished. Solurol was noticed to have a good effect in reducing insomnia.

§7. On drugs in general.

Other drugs at times useful are bromide of potassium, sodium, and ammonium, aspirin and antipirin, tinct chloroformi, and tinct chloroformi, c morphia, morphia, opium, and hyosyamus.

To cause rapid relaxation of gastric spasm during seizures, no drug employed is more efficient than nitroglycerine. Unfortunately this drug when frequently exhibited, loses efficiency. It may be given in doses of, $\frac{1}{100}$ th grain repeated if required. The dose can be raised to $\frac{1}{50}$ th of a grain. One of my patients mistaking trinitrine tabloids for rhubarb took five $\frac{1}{100}$ th grain tablets as a dose, previously he had taken $\frac{1}{100}$ th grain at the onset of seizures. Understanding the rapidity of action of this drug he thought it useless to send for assistance, and thinking the dose a fatal one, hurriedly wrote a short note informing his family of his mistaken action, undressed and went to bed. He fell asleep immediately. Next morning he awoke after a good night's rest, feeling quite well. In futile attempts to arrest a seizure I have known cases in which ten or twelve tablets, each containing $\frac{1}{100}$ th grain have been taken in the course of half an hour. Since the œsophagus is in a spasmodic state during the seizure it is doubtful, if always tabloids taken during the seizure, reach the stomach.

§7. On drugs
in general.

In cases in which many tabloids have been taken without any remedial effect I have noticed the occurrence of a sudden fall in systemic pressure about five minutes after the seizure had ended. Moreover, I have known instances in which inhalations of nitrite of amyl have proved instantly effective when trinitrine tabloids have failed to relieve. Frequent resort to nitro-glycerine has a hurtful rather than a beneficial effect.

Bromides are too slow in action to cut seizures short, but I have seen good effects follow their steady employment. Twenty grains of bromide of potash given when the patient is already in bed and when lights are low, usually prevents a restless night, and, not infrequently, saves the patient from early morning seizures. If bromides be selected for exhibition daily and for lengthy periods, the best results are obtainable from bromide of ammonium, taken in doses of ten grains, three times a day.

In several instances, I have found in bromidia (Battle) a highly efficient remedial agent. Half-a-teaspoonful, in combination with twenty drops of compound tincture of camphor, and fifteen drops of tincture chloroform, has secured a good night's rest and reduced frequency of seizures during the day.

When seizures are frequent and severe, I have observed good effects follow administrations of tincture chloroform c. morphia in doses of ten to fifteen drops, three times daily, and even when seizures are actually present, a dose of fifteen drops, brings not infrequently, speedy relief. When seizures are very painful, a subcutaneous injection of one-eighth grain of

morphia has a happy effect, bringing pain and spasm to an end. Aspirin, in doses of ten grains, brings relief in five minutes, and anti-pyrin takes a little longer time in making its virtues felt, but both these drugs soon lose efficiency of action, and have no permanent effects on the neurosis. Indeed, I think their frequent employment leads the stomach into more irritable courses and adds to the frequency of seizures.

I have noticed that seizures are modified in severity, and abort under the influence of hot applications to the abdomen and thorax. Flannel soaked in boiling water, rung out in a hot towel, and applied as hot as can be comfortably borne, tend to relax spasm. In a minor degree an indiarubber bottle filled with hot water serves the same purpose. Care must be taken, however, that the weight of the bottle is well supported, and is not allowed to rest heavily on the abdomen or thorax.

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Section 8. *On Deflation of the Stomach through Mechanical Means.*

EMPLOYMENT of the œsophageal tube as a method of treatment of the angina pectoris was advocated by me in an article in the British Medical Journal, March 18th, 1911, since then I have used the tube on many occasions and always with satisfactory results. Even when the tube gets blocked by frothy mucus, an event which not infrequently happens, imprisoned gas escaping from the stomach obtains vent at the side of the tube. In

§8. On deflation of the stomach through mechanical means.

§8. On deflation of the stomach through mechanical means.

one of the cases, related below, death was averted by this method of treatment.

On January 2nd, 1911, when I entered Dr. X.'s room, he was suffering from an anginal seizure, which had already lasted half-an-hour. He had been making ineffectual efforts to expel wind from his chest, and allowed me to introduce an œsophageal tube, a procedure which resulted in an exhaustive liberation of gastric flatus. The efforts of the operation became instantly apparent in the altered aspect of the patient. His colour returned, and he was no longer in pain. The seizure was at an end.

On the last day of January, Dr. X. informed me that on two occasions he had again resorted to the operation of gastric deflation, and upon each he had brought the seizure to a sudden and abrupt close. Dr. X. had suffered from anginous seizures from time to time for several years.

In another instance the patient was in a collapsed state, and the passage of the tube was rendered difficult owing to closure of the jaws and spasm of the œsophagus. After muscular contractions had yielded to steady pressure, gas and the fluid contents of the stomach were expelled with much violence, and instantaneous recovery occurred. In another case, namely, that of Miss E., seizures of a prolonged character were appearing with considerable frequency, necessitating a resort to the administration of nitro-glycerine several times a day, but irrigation of the stomach so far modified the character and duration of the attacks that no further recourse to the nitrites was found necessary.



Appendix.

Appendix I. The Protective Reflex.

Appendix II. Other Papers.

Note to protective reflex function.

Angina pectoris is an offspring of morbidity of protective reflex function. Centres of protective reflex arcs, lodged in the medulla and in cervical and thoracic segments of the cord, are seats of the neurosis. Hence the angina pectoris and the generic family of spasmodic complaints to which it belongs are appropriately regarded as examples of segmentary neurosis. To understand the symptomatology of the angina pectoris and the processes underlying it, it is essential that we should acquaint ourselves with the source of origin, and the nature of physiological protective reflex function, and those instinctive laws which control its activities. With the object of assisting the reader to arrive at true conclusions, I give below a brief sketch of the chief characteristics of this essential function under normal and healthy conditions.

Appendix I.

Protective Reflex Function.

Chapter I.

The First Law of Adaptation.

- Section 1. Introduction,
- Section 2. The basis of psychology in simple organisms.
- Section 3. The first law of adaptation stated.
- Section 4. The status extensionis and the status contractionis defined.
- Section 5. Schema of Modes of Adaptation.

Section 1. *Introduction.*

IN all animals, simple and complex alike, receptive and rejective reflex functions are practised. As shown below these functions are essential for the conduct of traffic between the organism and environment, and hence necessary for the maintenance of continued existence. Evolution cannot move a single step forward without provision being made—*pari-passu* with development—for the continua-

§1. Introduction.

§1. Introduction.

tion of these functions in the succeeding type of species. Since exclusion and rejection of the unsuitable thing from the economy of the organism, constitute the first principles in any conceivable method of protection, rejective reflex function is appropriately and conveniently called protective reflex function.

The purpose envisaged in receptive reflex function is extension of absorptive and impressionable surface in contact with a suitable medium; that in protective reflex function, reduction of extent of surface exposed to an unsuitable medium. In primitive organisms these functions are accomplished in the one case through extension of the protoplasmic bodily mass, in the other case through its contraction. Similar functional activities are operative in constituent bioplasts of organs tissues and parts of complex animals.

In man and higher animals the nervous mechanism engaged in conducting these essential functions consists of a number of bilateral reflex arcs centred in segments of the cord. One limb of each lateral segmental arc is grounded in the contractile tunic of viscera; the other in striped muscle of thoracic and abdominal walls, the diaphragm and the perineum. The centre of the reflex arc, as I have stated already, is seated in a segment of the cord. Here in segmentary centres are gathered, in juxta position, cardio-motor, vaso-motor, and secretory centres which take part in, and act in sympathy with, protective reflex function. The entire segmentary commune is in touch with higher centres of the brain, through an upper set of neurons. Through this medium, protective reflex

function is influenced by psychological, physiological, and sensory, as well as by physical impressions. The part played by protective reflex function in the economy, is best studied by comparative methods, beginning by observations of the reflex in simple organisms.

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Section 2. *The Basis of Psychology in Simple Organisms.*

THE theory of receptive and protective reflex function is based on the hypothesis, that every living thing, including the meanest tissue bioplast of the complex animal, possesses, in esse, or in posse, a complement of instinctive faculties, co-equal in essence and co-extensive in range, in all. This doctrine is recommended to our consideration because it is in accord with the teachings of evolution. For if faculties inherent in higher organisms and in man, or a fundamental psychology capable of generating them, be not in being from the beginning of things, whence come they, from the sky or from the earth, from east, west, north, or from south; or are they special gifts of Providence to favoured species?

§2. Basis of psychology.

This doctrine receives support from comparisons made between faculties possessed by simple organisms, and those of highly complex animals. To understand the significance of

§2. Basis of psychology.

psychological and physiological activities of complex organisms, we must begin by a study of the unicellular organism which is the prototype of the unit of life, the unit of instinct, the unit of structure, the unit of growth, and the unit of evolution in complex organisms, that is to say, the discrete particle of protoplasm of amœbic form.

The simple unicellular animal organism possesses no lungs, yet it inhales oxygen and exhales carbonic acid gas. Although it has no permanent stomach, it improvises one, draws into it particles of food and digests them in an acid medium. It is provided with neither intestinal canal nor with kidney, yet it expels detritus and excretes urea. Its basic protoplasm is not fashioned into tissues nor parts, nevertheless, it projects pseudopodia and moves from place to place. Neither heart nor arteries find a seat in its economy, yet nutrient fluids are circulated, supplying fuel to ultimate molecules, in every part. In obedience to appropriate impressions it exercises hypo-tonus, practises suction, and draws from environment those supplies which are necessary to satisfy the cravings of appetite. In obedience to a sense of aversion it exercises hyper-tonus, expelling the contents of improvised stomachs and repelling encroachment from enemies. No peripheral nervous system is installed, yet impressions are conducted along countless tracks through shapeless atoms. Although it has no organs of sight, hearing, nor touch, instinct is informed as to the nature of conditions of environment, and it responds to impressions from light and darkness, from vibratile waves, and from heat and from cold. No central nervous system is

installed, nevertheless, its movements are purposeful, and it discriminates between things harmless and things hurtful, between things suitable for food and things unsuitable, practising suction on the one and repulsion against the other. §2. Basis of psychology.

The foregoing statement is a short summation of evidence of the physiology and psychology of primitive animals collected from reliable sources. From it we learn that whatsoever differences be found existing in degrees of capacity of faculties among animals of divergent types of species, fundamental principles are the same in all. This doctrine also teaches us that tracks are trodden by sensible impressions through shapeless particles of protoplasm, before neuronie roads are laid. That contraction and extension occur before muscle cells come into being. That secretion and excretion proceed, without assistance from cells specially designed for these functions, and that communes of cells, called organs, are constructed to house faculties, long after faculties themselves are in active operation.

Upon the basis of these considerations, we begin our enquiry into the nature of protective reflex phenomena.

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Section 3. *The First Law of Adaptation, Stated.*

§3. First law
of instinct.

IT is a first principle, that continued existence is dependent upon potentiality of the organism to conduct economic traffic with environment, to take, to ingest, and to assimilate, food stuffs, food salts, and oxygen, from the medium of environment, to protect itself against absorption of unsuitable matter and to expel detritus and excrement from visceral spaces, tubes, and cavities. For this reason simple and complex organisms alike enjoy faculties of attraction and suction, and for this reason also, they possess powers of expulsion, repulsion and exclusion.

Through powers of tonus, the genius of instinct conducts traffic between the organism and the medium of environment. Energies engaged in reception of food, are set in motion through practise of hypo-tonus; whereas functions belonging to the protective category, are creatures of hyper-tonus.

The psychological incentives, appetite and aversion, are primary incitements of action, but whether appetite shall be indulged or suppressed and whether energies at the disposal of aversion shall be given rein, or held in leash, are questions decided through experience, habit and judgment.

Through its senses instinct is in touch with conditions and things appertaining to environment, and its judgments are framed in accordance with interpretations placed upon sensible

impressions. Responson of instinct are not determined through direct stimulation of the tissues by external agencies ; but through interpretations placed by instinct upon the nature of such impressions. Instinct is sole judge of the significance of sensations, and selects the form of response which shall be made to them.

In this matter instinct follows a definite rule of conduct of universal application.

To impressions deemed suitable, the response is hypo-tonic ; to impressions deemed unsuitable, it is hyper-tonic.

This is the first law of adaptation.

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Section 4. *The Status Extensionis and the Status Contractionis Defined.*

THROUGH the instrumentality of hypo-tonic and hyper-tonic energies the bodily frame of the organism is adapted, to fulfil the several requirements of situation and occasion. Through hypo-tonus the status extensionis or receptive phase is produced. Through hyper-tonus the status contractionis or protective phase is established.

§4. Status extensionis and status contractionis.

The material constitution of the simplest form of unicellular organism consists of a nebular aggregation of particles of protoplasm, void of containing envelope, but held in apposition by the vital energy of tonus. Like steel filings, in the

§4. Status
extensionis
and status
contractionis.

presence of negative magnetism, particles of the nebular mass are driven apart by hypo-tonic energy. A suctional and nutrit stream, determined by the void, is drawn from environment and enters interstitial spaces ; conversely like steel filings in the presence of positive magnetism particles of the body mass are attracted towards one another by hyper-tonic energy and a reverse stream carrying with it waste products of metabolism, is returned to environment.

An illustrative analogy is found in the immersed and compressed sponge, when compression is relaxed a centripetal stream enters at open channels ; when the sponge is compressed, a centrifugal stream is set in motion.

The blood stream of complex organisms is the medium of environment of tissue bioplasts. From this source, instinct influenced through the craving of appetite, incites constituent bioplasts of tissues, to suck food stuffs, food salts and oxygen. Into this medium again, at the instance of aversion, carbonic acid, urea, and other waste products of metabolism are returned. In highly complex animals these waste products of metabolism constitute the internal stimulus which determines contraction of constituent bioplasts of the myocardium during systole. It would appear that rhythmic function of all tissue bioplasts is instigated by alternating suggestions determined by appetite and by aversion.

Hypo-tonus introduces an extensile, suctional assimilative, impressionable, and withal, a receptive phase of being, whereas hyper-tonus determines a contractile, repulsatory, expulsatory, secretional, refractory, and withal, a protective phase of

being. During amplification of the receptive phase, areas of §4. Status
absortive and impressionable surface exposed to influences extensionis
from an adverse environment is reduced to its smallest and status
possible dimensions. contractionis.

Simple unicellular organisms and also tissue bioplasts, which are constituent units of organs, tissues, and parts are alike subjects of reflex hypo-tonus and hyper-tonus, excited respectively by suitable and by unsuitable impressions.

The meaning of terms "suitable" and "unsuitable" in reference to conditions of environment is explained as follows:—Food stuffs, food salts and oxygen, the requisites of life, are brought to the doors of the primordial bioplast, suspended or dissolved in the medium. But the question whether the bioplast shall take the proffered meal or refuse it, depends upon other considerations besides those relative to the quality of the food. The food stuff itself perhaps is suitable, but media holding it in suspense may be polluted, cold, or shaken by disintegrative vibrations. These are conditions of unsuitability which determine an adverse response. Moreover in the absence of light or oxygen the bioplast finds reasons for refusal of the meal. For instance, bioplasts of many species, instantly assume the status contractionis when light is occluded, or when plunged in distilled and airless water.

During ages of time when first principles were being inculcated and when early habits were being formed, no organism mightier than the bioplast, itself, had a place in environment. Consequently the bioplast entertained no

{4. Status
extensionis
and status
contractionis.

conception of an environment rendered unsuitable through conditions, except such as appertain to qualities of food stuff, climatic vicissitudes, currental disturbances and pollution. In the presence of any of these unfavourable conditions the status contractionis is assumed. Conditions of environment whether favourable or unfavourable, if strange to experience also evoke the protective phase.

Associated with the status extensionis faculties of suction, assimilation, elaboration of secretional bodies, hoarding of these bodies and food stuffs, erection of tentacles and psuedo-podia, and mobility, are enumerated. Whereas associated with the status contractionis are found faculties of expulsion of contents, of visceral cavities, retraction of tentacles, and pseudo-podia, exudation of secretional matter; cyst formation, cell division, spherification, coiling, and crouching.

In obedience to provisions of the first law of adaptation when conditions of environment are deemed suitable, simple organisms enter upon the status extensionis, or receptive phase of being. During initiation of this phase the bodily frame is expanded, tentacles and psuedo-podia are projected, and suction cavities, usually designated improvised stomachs, are formed. Into these vacuoles, bioplasts suck minute solid particles of food, and through pores in circumferential tissues, they draw soluble nourishment and air. While the status extensionis continues, receptive faculties remain engaged, traffic between the organism and environment is brisk, senses are alert, mobile functions are active and assemblage in fertile fields, for foraging, for social, and for sexual congress, is a

common practise. A social assemblage sometimes takes the form of a permanent economic assemblage. Bioplasts meeting on common ground, run together, and like drops of mercury or oil, coalesce, leaving no line of delimitation between them. A peculiarity of these socio-economic gatherings, is this, as soon as cohesion is effected, co-ordination of activities is established, and hence forward the entire assemblage moves in unity of purpose and action. As in the case of single unattached organisms, plasmodia, as these assemblages are called, assume the status extensionis or the status contractionis, in obedience with provisions of the law of adaptation. Extensile and contractile energies are mutually inhibitive. It is here to be remarked that socio-economic assemblages are formed by bioplasts of a naked and simple type, bearing a family likeness.

Conversely when conditions of environment are deemed unsuitable bioplasts enter upon the status contractionis; a protective phase of being. Tentacles and psuedo-podia are retracted, suction cavities are closed, their contents are expelled and a spheroidal configuration is assumed, exposing the smallest possible extent of impressionable and absorptive surface to adverse influences of the medium. The exercise of contractile energy reduces bulk, hardens surface tissues, increases specific gravity, and precipitates the bioplast to deeper strata of the medium.

When states of unsuitability are prolonged, formative plasma exuding upon circumferential surfaces, forms an impervious protective covering. Owing to sticky properties of

§4. Status
extensionis
and status
contractionis.

formative plasma bioplasts precipitated *en masse* adhere and form clumps, which mature into colonies ageloid, spheroidal, arboriform, or catenoid. When bioplasts are precipitated singly and remain isolated and unattached, and when periods of unsuitability are unduly protracted, coats of plasm become horny, carbonaceous, siliceous, or calcareous and organisms are then said to be encysted. Formative plasma holds plastids in suspension. These secretive bodies consist of an oleaginous base and are present in many varieties, pigmentary, aromatic, solvent, zymetic, and nutritive. In the course of the exudative mode of adaptation, cell division takes place.

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Section 5. *Schema of Modes of Adaptation.*

§5. Modes of adaptation.

THE status extensionis is divisible in five modes. During amplification of the status extensionis or receptive phase of being, senses are alert, emotions are readily awakened, and faculties of observation, conduction, discrimination and judgment, are active; absorption, assimilation go on space, and waste products gather. Locomotion is practised. During seasons of frequency of the status extensionis potentiality of faculties engaged in its amplifications become enlarged.

Mode 1. Extent of impressionable and absorptive sur-

faces in contact with the medium is widened, tentacles and pseudo-podia are projected and amorphous forms are assumed. }4. Status extensionis and status contractionis.

Mode 2. Suctional and attractile energies are generated and suction cavities are improvised.

Mode 3. Partially digested food stuffs and secretional matter is stored.

Mode 4. Mobility is practised.

Mode 5. Assemblage of bioplasts in economic communes occurs and sexual congress take place.

The status contractionis is divisible into four modes. During amplification of the status contractionis or protective phase of being senses are numbed, emotions are sluggish, and faculties of observation, conduction, discrimination and judgment are inactive. Secretions and waste products of metabolism are exuded. Mobility is stilled. Frequent resort to the status contractionis results in enlargement of faculties engaged in its amplification.

Mode 1. Extent of absorptive and impressionable surface in contact with the medium is reduced and spheroidal, and in the case of elongated organisms, coiled forms are assumed.

Mode 2. Expulsatory energies are generated and suction cavities are emptied and closed.

Mode 3. Formative plasma and secretional plastids are exuded upon circumferential surfaces. Formative plasma after a while hardens and becomes chitinous, carbonaceous, or calcarious, and cyst formation occurs. Cell division is a feature of this mode.

§4. Status
extensionis
and status
contractionis.

Mode 4. Formative plasma exuded by bioplasts to form circumferential coverings for the protection of absorptive and impressionable surfaces in contact with unsuitable environment, becomes the nexus of clumps and colonies. Through entrance into aggregated assemblages, bioplasts still further reduce area of superficies exposed to adverse media.

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Chapter II.

Laws of Adaptation, Chiefly Applicable to Multi-Cellular Organisms ; Second and Third Laws.

Section 1. The Second Law of Adaptation.

Section 2. The Third Law of Adaptation.

Section 1. *The Second Law of Adaptation.*

THE second law of adaptation enunciates the principle that,

Faculty grows through usage, and through disuse decays.

Division of labour, among constituent bioplasts of the economic constitution of multi-cellular organisms, is a settled principle. Every sense, faculty and function being conducted by groups of constituent bioplasts, specialised in the faculty, particular and peculiar to offices held by them in the economy.

The liver is a group of bioplasts, whose special function it is, to secrete bile. The group called kidney is engaged in secretion of urea. Bioplasts of muscular tissue conduct con-

§1. Second
law of
adaptation.

§1. Second
law of
adaptation.

tractile faculty. Those of peripheral nervous tissue are specialists in conductivity. Groups of bioplasts called organs of sense represent respectively, faculties of sight, smell, taste, hearing, and touch. Again, groups forming functional parts of brain substance are experts in faculties of memory, discrimination, reason, and judgment. Osteoblast secretes plasma rich in earthy salts. Whenever occasion requires derma-blast, thelio-blast, and connective tissue bioplast, concentrate instinctive energy on secretion of plasma and cell division. In man, every constituent bioplast in the economy is habituated to concentrate instinctive energy upon the exercise of a single and particular faculty. So all bioplasts which are constituent living units of tissues, are specialists in the exercise of a single faculty alone, and this specialised faculty is employed in communal service.

But constituent bioplasts of organs and tissues, like all other living things, are endowed with a full complement of faculties which are essential to the continued existence of their own individualistic systems ; for proof of this statement we rely on the fact that tissue bioplasts when transplanted and grafted upon an alien but suitable soil, still retain potentialities of feeding themselves, of growing, of developing, and of reproducing their kind.

Division of labour in the economic commune leads inevitably to predominance of a single faculty above the rest of the complement. This is so, because, not only has a faculty, engaged in communal office, to work in the service of its own individualistic system, but in that of the communal body as

well. In the latter occupation it is under regular persistent and particular employment. So in accordance with the law enunciated above, bioplasts holding office in the economic constitution of multicellular organisms, at length become experts in employment of a particular faculty which outclasses all others in the complement.

Predominance of a single faculty in the complement of living units of tissues, namely, specialisation of faculty adapts these tissues to serve communal requirements in the most efficient manner possible. It is a mark which distinguishes the multicellular organism from the simple. It is the chief sign of evolutionary development.

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Section 2. *The Third Law of Adaptation.*

ORGANISMS beget organisms like unto themselves. §2. Third law of adaptation
 Offspring of constituent bioplasts of tissues organs and parts of multi-cellular organisms inherit instinctive potentialities, similar in extension, essence and kind to those possessed by parent stock.

This law is operative in plants and in animals. Through its provisions, constituent bioplasts of multi-cellular organisms retain the predominating features of instinctive faculties and habits through succeeding generations.

§2. Third law
of adaptation.

The less complex the type of organism be, the closer the likeness between offspring and parent becomes. In the case of mammalia, a likeness exists between parent and offspring; less so in man than in others of the sub-kingdom. In reptiles the likeness is more complete. It is difficult to distinguish between frog and frog, and between snake and snake. As for fish in the shoal, no differential marks can be detected. Mature snail resembles, in every feature, the parental stock. Resemblance between protozoon and protozoon of a family is exact. Exactitude exists between offspring and parent of constituent tissue bioplasts of multicellular organisms. In the absence of proof it is not irrational to infer that offspring of neuro-blast, myo-blast, osteo-blast, and dermo-blast register every advance towards specialization of communal faculty, attained by the parent stock.

Through the operation of this law, evolutionary processes are continued in offspring, at the stage where they leave off in the parent. Since each constituent unit of the unicellular organism presents the same instinctive features as the entire organism, cell division provokes no appreciable pause in evolutionary progress.

In accordance with this view we regard organs, tissues and parts of multicellular organisms as family assemblages of bioplasts derived from common parental stocks. Members of each commune are endowed with specialised faculties inherited from a remote ancestry: specialised faculties which particularly fit them for the service of offices severally held by them in the economic commune.

Chapter III.

Examples of Adaptative Processes.

Section 1. Adaptative Processes in Plants.

Section 2. Adaptative Processes in Animals.

Section 1. *Adaptative Processes in Plants.*

ORGANIC changes occurring in organisms during growth from embryonic forms to mature, furnish examples of obedience to the laws of adaptation. §1. Adaptative processes in plants.

Evolution is founded on the principles of adaptation. Constituent bioplasts of tissues of organisms are ever engaged through the practise of faculty, in adapting their physical shape and psychological powers, in accordance with requirements made upon them by a changeful environment.

The argument followed in previous chapters leads us to the conclusion that only those faculties which are particularised for communal service take part in communal work, and that the rest of the instinctive complement, inherent in constituent

§1. Adaptive processes in plants.

tissue bioplasts, are engaged in functions proper to the individual systemic requirements of those unitary organisms themselves.

Since faculties engaged in assimilation and digestion of food are equally in requisition in lower forms, as in higher, no great evolutionary changes are observed in these faculties.

In accordance with the second law of adaptation, faculties of the instinctive complement, except such as are specialised in communal service, tend towards decadence. Consequently, faculties operative in unicellular organisms, not infrequently pass into disuse and lie in partial or complete abeyance in constituent tissue bioplasts of complex multi-cellular organisms. For instance, the simplest constituent bioplast of the complex multi-cellular organism, and the most highly endowed with faculties of locomotion, and with certain sensory qualities, is the phagocyte of the blood tissues. Yet this organism cannot be compared in several high faculties with the actino-bolus radians which pursues and captures quarry with the skill and cunning of an aboriginal tracker. Faculties of a high order not infrequently apparent in multicellular organisms in embryonic stages of being, fall into abeyance when a mature stage is reached.

Organic changes follow in the lines of functional activities occurring during amplification of the protective phase of being defined in mode 2 of the schema of adaptative modes. The faculty engaged in the secretion of formative plasma which provides primitive organisms with protective covering during seasons of unsuitability of environment, and the faculty of cell

division are chief factors in evolution of structural form. An example is noted in the labours of bioplasts in building the honeycomb structure of axis cylinders of stems of growing plants. Each cell is occupied by a bioplast which fashioning the structure of its own wall, takes an infinitesimal but fundamental part in fashioning the structure of the stem. These bioplasts are specialists in the faculty of secreting lignin which constitutes the hard, incompressible, and sustaining property of woody fibre.

If a cell be examined under the microscope the character of the work in progress is readily understood. The wall consists of several layers buttressed at weak points by cornice, panel, pilaster and wainscoting, all designed with the purposeful intention of resisting strain or supporting weight. In cells upon which the greater weight falls, walls are proportionately thick and well buttressed. In those exposed to little pressure, amount of building material used is small.

Guided by a knowledge of the laws of adaptation, we are in a position to make a good guess as to how tenants of these cells have engineered the structure of the walls after a manner so masterful. In accordance with the first law of adaptation and in response to impressions from strain or pressure deemed unsuitable, the bioplast exudes a covering of formative plasma containing in suspense plastids of lignin. At that fractional area of the circumferential surface where unsuitability is chiefly felt, exudation is more abundant than elsewhere. At all parts of its superficies, the bioplast maintains close contact with the cell wall, and wheresoever pressure is felt, there exudation

§1. Adaptative processes in plants.

§1. Adaptive processes in plants.

takes place. Placs of lignin are therefore deposited in measure and in thickness exactly proportionate to the degree of pressure felt. Through this agency work done by constituent bioplasts of stems of plants displays purposeful features.

The reason why the faculty of secretion is so highly developed in this species of bioplast is equally plain. The faculty of secretion has grown through frequent usage ; this in accordance with the second law of adaptation.

Lastly, in accordance with the third law. This particular faculty specialised through regular employment has become a potentiality transmissible from parent to offspring.

The specialised secretory faculty inherent in constituent bioplasts of the axis cylinder is also possessed by constituent bioplasts of the cortex. In the former instance instinctive energy is concentrated in fixing a barrier against weight and strain, in the latter against cold atmosphere and against the corrosive influence of rough, biting winds. Although in both instances the secretory faculty is under specialisation and abundance of formative plasma is exuded, a difference is observed in the character of plastids suspended by it. In the case of the axis cylinder, chief plastids are lignin and earthy salts notable for their sustaining properties, whereas chief plastids exuded by constituent bioplasts of the bark are cork and tannin, the latter a protective of considerable potency against microbic invasion, the former possessing properties valuable in prevention of radiation of heat and in neutralising rude vibratile impressions. Besides these particular bodies, secretions of bioplasts of the cortex are rich in colouring matter

calculated to withstand the glare of meridional suns. These are differential characteristics of specialisation of secretory faculty. §1. Adaptative processes in plants.

Through resources drawn from highly specialised secretory faculty, cortical bioplasts find means of protection against vicissitudes of fickle environment. An example of its method of practice is observed in the contrast between bark and foliage at the side of a tree exposed to buffeting from keen blasts, and structures of a similar kind on the sheltered side. At the exposed side bark is thick and rough, bulging and fissured through abundant outpours of suberin, and activity of cell division. Whereas at the sheltered aspect, bark is smooth and attenuated. In examples given, adaptative measures introduced by constituent bioplasts of tissues have altered the structural features of plants in accordance with protective requirement. They are significant of the part played in the evolutionary role, by constituent bioplasts, through specialisation of faculty.

Plants grown in the open air present differential features distinguishing them from plants grown under glass, and these features, when analysed, are noticed to display protective characteristics; namely, profuse outpour of suberin and plastids, and an abundance of the products of cell division. These robust characteristics are very apparent in perennial plants of high latitudes accustomed to withstand the rigours of harsh climates. In this latter instance the potentiality of reproducing these essential features in highly efficient proportions has become transmissible through high special-

ization of constructive faculties during a course of protracted acclimatization.

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Section 2. *Adaptative Processes in Animals.*

§2. Adapta-
tive processes
in animals.

AN example of obedience to the second law of adaptation is noticed in the growth and decay of the faculty of contractility in muscles of the limbs in direct ratio with the measure of their employment. In the case of the musculature of the arm or leg, shoulder or hip, the faculty grows through exercise of the limb, and wanes when the limb is kept at rest. Apart from considerations of stiffness at joints, when movements of the healthy arm are restrained for several weeks by well adjusted splints, contractile capacity of its musculature becomes almost extinct, and myoblasts wither and decay. Visceral muscle also is obedient to this law. Muscular elements of the heart increase in number, and contractile power grows in direct ratio with output of effort required to overcome peripheral resistance. In the muscular tunic of the intestine, muscular elements increase and contractile capacity grows proportionately with efforts to overcome functional or organic obstruction of the tube. On removal of obstruction capacity of this faculty falls to the standard of normality. On account of changes in the bulk of muscle, attending alterations in the capacity of faculty, these

phenomena are called respectively in clinical parlance hyper- §2. Adaptative processes in animals.
trophy and devolution. Secretory faculty is governed by the same instinctive law. After extirpation of a kidney, the single organ left, soon acquires capacity of output equal to that formerly enjoyed by the joint efforts of itself and its fellow.

The measure of exercise of a faculty is determined by the degree of stress of official requirement imposed upon it by instinct. In making demands instinct is governed by the first law of adaptation. The measure demanded is precisely proportionate to requirement, no more and no less. For instance, output of myocardial energy is in direct ratio with peripheral resistance, output of energy of the muscular tunic of the intestine is in direct ratio with degrees of resistance caused through obstruction against the onward flow of the intestinal stream, and output of energy of secretional bioplasts of the kidney is exactly proportionate to accumulation of waste products of metabolism in the blood stream. Examples given above relate to physiological function but whether faculty be physiological or psychological the same laws are applicable.

A good illustration of the principle that the faculty of cell division is a mode of expression of the protective reflex, is furnished by the dermoblast which proliferates when under stress of pressure, friction, or irritation, or other kinds of unsuitable impressions. Continued pressure over the dermis of the foot produces indurations consisting of many generations of epidermal cells held captive in formative plasma. Indurations of the hand of the artizan are examples of cell division and production of formative plasma under persistent friction. The

§2. Adaptive processes in animals.

wart is an example of localized dermal proliferation at the instigation of an irritative body.

In the manner of working, specialised faculty in the animal resembles that of the plant. Dorsal integuments are more largely exposed to vicissitudes of environment than those of the ventral surface. The ventral surface derives some degree of protection from cold and friction through habits of coiling, crouching, and approximating this section of the body surface to the dry earth or sea bed during periods of unsuitability of the elements. Consequently dermoblasts of the dorsum undergo protective adaptation through exercise of specialised faculties of cell division and plasma production. As a result of the work of these units of structure, thickening, hardening, and impermeability occur.

Shell, scale, quill, and feather, down, hair, and bristles, tooth, tusk, nail, and horn, are examples of the work of dermoblasts possessing secretive faculty specialised after its kind to resist the rigours of unsuitable environment.

The osteo-blast practises cell division and production of formative plasma containing earthy salts in profusion in the presence of irritative or otherwise unsuitable agencies. Callus which surrounds a fractured bone consists of a multitude of young osteo-blasts suspended in a nexus of formative plasma.

The same principle is discerned and the same faculties are employed by osteo-blasts engaged in laying down hard plates in Harversian systems of bony substance to bear the weight of superstructure, and faculties employed in similar kinds of labour by bioplasts of the axis cylinders of stems of plants.

Chapter IV.

Evolution of Instinctive Habits.

- Section 1. Evolution of Instinctive Habits.
Section 2. Coiling a Protective Expedient.
Section 3. Cocoon and Nest Building.
Section 4. Facial Expression and Bodily Pose.

Section 1. *Evolution of Instinctive Habits.*

INSTINCTIVE habits related to the protective phase, §1. Evolution of instinctive habits.
more lasting than structural configurations of species, are habits.
evolved through obedience to the law of adaptation.

All forms of habit are instinctive. Volition may take part in the formation of habit. But habit once established is invariably put into practice through the promptings of instinct.

During practice of protective reflex function, animals, through spherification, through coiling, or through approximation of the ventral surface to the earth, reduce absorptive and impressionable surfaces exposed to an unsuitable environment to the smallest dimensions possible.

§1. Evolution
of instinctive
habits.

Through habits of rapid proliferation and production of formative plasma, acquired by dermoblasts of dorsal integuments of primitive animals, protection against the rigours of environment is afforded, and thereby the dorsal surface is differentiated from the ventral. These adaptative phenomena are in accordance with mode 3 of the protective phase.

Coiling in presence of an unsuitable medium is practised by protozoa of certain species. Under similar conditions of environment it is practised by annulata and by articulata, and it is also adopted by numerous varieties of mollusc and vertebrate. Necessity has driven animals of simple and complex form alike to perpetuate a habit which enables them to adapt their frames to conform with requirements of situation and circumstance. Through frequent practice faculties engaged in the pursuit of the habit have become specialised, and the habit itself has taken a place in the instinctive complement. Through practise of this habit, by elongated spineless animals, zonal segmentation has been effected, and through persistency in practise, segmentation and articulation of the spinal column and articulation after a manner permissive of anterior flexion, have resulted. The necessity of observing obedience to requirements of the instinct of self-preservation has in the first instance determined the formation of the habit, and this habit, once having acquired a place in the instinctive complement, has retained it. The habit of coiling, practised by countless generations of animals, has been a mainspring of direction of evolutionary energy, resulting in segmentation, articulation, and in other structural

developments which give particular forms to divergent species of complex organisms.

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Section 2. *Coiling, a Protective Expedient.*

WITH few exceptions, at nightfall, animals pass ^{§2. Coiling a protective expedient.} under the influence of protective reflex activities,

because instinct regards nocturnal hours as unsuitable for pursuit of traffic with environment. This instinctive conception probably takes its origin from a custom universal among organisms of vegetable species, which, in the absence of sunlight, are unable to manufacture food from gaseous elements of the atmosphere. Probably sleep and hibernation also, had the same source of origin, for in this respect the cold atmosphere of winter months is equally inhibitory of food getting, as darkness.

The habit of passing under the influence of protective reflex activities at nightfall offers grounds for a rational explanation of home-coming habits at sunset, prevalent in many divergent species. Rooks abandon their feeding grounds when light begins to fail, and hasten their return to their several nesting places. Bee seeks its hive, and fowl its pen. Snail is drawn into its shell, and numberless species of animals find cover in crevices of the earth, in clefts of rock, and in holes

§2. Coiling a protective expedient.

in trees. In sleep they coil or assume a pose as near as possible to that imposed through coiling. The infant in its cot tucks up its knees beneath its chin, dogs and cats coil on the hearth-rug, and the perched canary, head under wing, retracts its shanks, depresses its tail, raises its feathers, and through these means assumes a rounded shape, exposing the least possible extent of surface to that which instinct regards as unsuitable environment.

Injury, and the fear of injury, are stimuli as efficient in the induction of the coiled pose as are influences of nightfall and sleep. When it hears a footfall on the path, or baying hounds from the distance, hedgehog coils and bristles its quills. Caterpillars coils when molested by a touch, and so do earwig and woodlouse. When alarmed by attack, cat arches its back, raises its fur, and presents a rounded contour. At threat of the whip, dog crouches, approximating its belly to the ground, or coils. The terror stricken spider rolls itself into a ball in presence of a humming fly entangled in its web. At the roll of thunder birds raise feather and fledglings crouch in their hollow nests. Insects assume contractile forms, and even daisy and buttercup enclose their soft thalami beneath improvised tents of petals.

The above examples illustrate operations of the protective reflex and instinctive habits which have been formed thereby.

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Section 3. *Cocoon, Comb and Nest Building.*

A MOEBOID protozoa acting independently and §3. Cocoon,
comb and
nest building.
unattached in presence of unsuitability of environment, exude a glutinous covering, and when unsuitability continues, the covering hardens and becomes chitinous, calcarious, or carbonaceous.* Where the organism consists of an economic commune of simple bioplasts, and when in turn it is exposed to unsuitable conditions, a rind is formed by bioplasts situated on its external surface through pursuance of a like method of protection. In a former article it is explained that the rind of trees and integuments of animals under exposure to unsuitable climatic conditions evolve protective appendages.†

In a further stage of evolution the dorsal aspect of the organism is differentiated, and absorption and secretive traffic with environment is conducted from the ventral surface. Later still the ventral surface assumes a concave formation, which still later becomes deep, while its bilateral borders unite enclosing a space which forms an intestinal tube, open at either end.

While yet the organism remains simple and before dorsal and ventral surfaces are differentiated or a ventral concavity is

*Protective reflex, mode 3, p. 305.

†pp. 315 and 318.

§3. Cocoon, comb and nest building. developed secretions exuded on the circumferential surface form a protective envelope. Later they are exuded from the ventral surface. After the intestinal tube has been evolved formative plasma and other protective secretions are exuded, not from circumferential surface, nor yet from ventral, but from proximal and distal orifices of the enclosed tube, chiefly from the proximal.

From this source of supply, cocoon building animals draw their building material. With a single secretive thread, exuded from the oral orifice, silkworm weaves a cocoon, and with a filament, from a similar source spider spins its web, frames its hutch, imprisons its victim, and wraps it in a winding sheet. Secretion of the same basic form as that exuded from the circumferential surface of the bioplast and employed in building the cell wall is drawn in more advanced species, from the oral orifice and used for cocoon building and for other protective purposes. Just as bioplasts excrete toxic plastids from the circumferential surface for protection from aggressive enemies, so insecta envenom sting with toxic products. In virtue of protective reflex activity snake poisons wounds from tooth or tongue, and scorpion projects envenomed sting. Through protective reflex activity octopus envelopes its retreating shape in a covering cloud of soepia.

Saliva is a retrograde form of formative and protective plasma. With saliva as the binding basis and with particles of inner lining of bark, triturated to form a cement, wasp frames the cells of its comb and covers them in a papyrous dome. Whereas bee, following activities directed with a like

purpose, and guided by tradition fetched from a more remote ancestry, exudes building material wherewithal to construct its comb, from pores opening upon the circumferential surface and from beneath pectineal scales.

The plan of mixing formative plasma with grosser material of an extraneous character, and thereby reinforcing structure, as practised by the wasp, is in vogue among species of birds. Concrete of the nest of the swallow is sand, or mud gathered from the road side, swallowed, churned up with formative plasma, and disgorged to mould the foundation and construct the wall of the overhanging body of the nest. With formative plasma from a similar source, chaffinch binds in a close knitted texture, twigs, leaves, hay, hair, wool, and feather, and with this building material, frames a nursery for the future accommodation of a family of fledglings.

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Section 4. *Facial Expression and Bodily Pose.*

FACIAL muscles are developed from contractile tissues of the proximal end of the alimentary canal and organs of special sense and discriminating faculty, from the disc of protoplasm which in early stages of evolution subtends oral tentacles and surrounds or partially surrounds

§4. Facial expression and bodily pose.

§4. Facial expression and bodily pose.

the oral orifice. So organs of expression, sense, and discrimination in man are appendages of the food track, and their original purpose is associated with intake of suitable food stuffs and with rejection of the unsuitable. For this reason, in early infantile life, the character of facial expression of the child changes with every gust of wind, which searches the stomach and raises ripples in the walls of the intestinal tube. Muscles of facial expression are instruments of receptive and protective reflexes which are excited into action by suitable or unsuitable impressions springing from intestinal sources. The risus sardonicus, significant of the throes of the anginous seizure is engineered by morbid reflex protective processes springing from gastric spasm. Receptive and protective reflex functions associated with the evolutionary history of the alimentary canal are primary incentives of facial expression.

The smooth unruffled face of satisfaction, contentment, and love, is an example of the receptive phase of being, whereas, the wrinkled face of dissatisfaction, discontent, and hatred, represents the protective phase. When honey is proffered to the infant, it opens wide its eyes, relaxes its facial muscles, extends its lips, and practises suction. Whereas, when castor oil is administered it contracts its brows, shuts its eyes, draws tight its lips, clenches its jaws, arches its tongue, approximates pillars of its fancies, and practises expulsatory energy. The bare thought of honey and castor oil calls into practise a corresponding instructive habit of expression. The pout of desire, and the pout of sulkiness, the one induced through extension of the lips, the other through sphincterial

contraction, present marks of distinctive differential significance which cannot be mistaken. They bear no more semblance one to the other than that which is borne between the expansive expressions of pleasure and the drawn features of suffering.

§4. Facial expression and bodily pose.

The expansive characteristics of the receptive phase and the contractile marks of the protective phase are envisaged in poses assumed by the bodily frame.

Erect figure, shoulders set back, free extensile movements of the arms, upraised eyes, open brows, straightened knees, wide stride, and bold thought and language, are marks of prevalence of receptive reflex function, and envisage the mentality of the successful and self-satisfied man. Whereas bent figure, forward shoulders, bowed head, knitted brows, downcast eyes, pinched face, retracted arms, shambling gait, feeble thought and hesitating speech, are marks of prevalence of protective reflex function and envisage the mentality of the unsuccessful man conscious of defeat in the struggle of existence against an adverse environment.

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Chapter V.

Physiological and Pathological Processes.

Section 1. Physiological Processes ; Protective Reflex Function in Tissue bioplasts.

Section 2. Pathological Processes.

Section 1. *Physiological Processes ; Protective Reflex Function in Tissue Bioplasts.*

§1. Physiological processes.

SINCE constituent tissue bioplasts retain protective habits inherited from a remote lineal ancestry, living independent existences as unicellular organisms, so they also practise as did their forefathers functions associated with the protective phase, namely, contractility, secretion of formative plasma, and plastids and cell division. Specialisation has modified these functions in highly complex animals. Tissue bioplasts specialised in high faculties of sense and reason suffer modification through reduction in intensity of other faculties. Faculties of secretion and cell division lie in abeyance. But dermo-blast, fibro-blast and osteo-blast

possess these faculties in specialised form. Specialisation of the dermo-blast in the production of formative plasma and plastids in many varieties is one of the earliest achievements of evolution.

Through employment of specialised faculties of secretion and cell division bioplasts of organs, tissues and parts, evolve structures through which they become better adapted to meet requirements of those offices held by them in the animal economy.

When layers of dermo-blasts are exposed to unsuitable influences of environment, for instance, friction, formative plasma is produced in abundance and cell division is active. Formative plasma after excretion, looses its watery elements, hardens and indurations are formed. Induration is a physiological protective expedient. When integument is exposed to strong sunlight its unitary constituents produce pigmentary plastids and protection of these delicate organisms is furnished against the intensive glare of sunlight.

Connective tissue bioplasts exposed to pressure or tension, exercising specialised faculty, excrete formative plasma and indulge in cell division. Fibro-blasts under similar conditions employ the same faculties. When friction between bundles of muscular strands becomes intensive, bioplasts of the fibrous sheath protect themselves and form silvery aponeuroses and when traction through the growth of muscle becomes increasingly urgent, through their special functions they add strength to muscular attachments. Bone also grows in sustaining capacity through exercise by its osteo-blasts in the

§1. Physio-
logical
processes.

specialised faculty of secreting earthy salts in abundance. These things are done by dermo-blast, fibro-blast and by osteo-blast under stress and strain. They are physiological activities. They are protective expedients. Owing to them the hand of the artizan becomes adapted to bear the strain and stress imposed on it by use of tools of his craft.

Through employment of specialised functions, bioplast of kidney adapts its structure to efficiently scavenge the blood, and, in the event of destruction or removal of its fellow, to bear further burdens imposed on it.

Through employment of specialised faculties of secretion and cell division all organs, tissues, and parts evolve structures through which they become better adapted to meet requirements of those offices held by them in the animal economy.

Requirements of office are determining factors in specialisation of faculty. Faculty employed in office becomes specialised, while other faculties in the instructive complement wane and fall into abeyance. Among tissue bioplasts holding office in lining membranes of stomach and intestine, are many employed in absorptive faculties. In accordance with the character of faculty specialised they select food suitable to their several constitutions, absorb them and pass them on in altered form into the blood stream. Certain bioplasts of the lining membranes of the alimentary canal select proteids, others mono-saccharoids, others di-saccharoids, and others again fats. In lining membranes of stomach and intestine are found tissue bioplasts specialised in the production of many varieties of secretion. These secretions are plastids exuded

for protective purposes. When foodstuffs are unsuitable for absorption they are rendered suitable through the effect of secretion poured upon them. This work is done under stress of requirement of office, and when all foodstuff entertained by stomach and intestine is made suitable for absorption and assimilation, labours of secretional tissue bioplasts cease.

Chief faculties employed by muscle tissue bioplasts are those of hypo-tonus and hyper-tonus, highly specialised to serve the purpose of office. All unicellular bioplasts, and all tissue bioplasts of multi-cellular organisms practise powers of tonus. They are instruments of nutritive faculties. Muscle bioplasts differ from the rest in the matter of specialisation of these faculties. Appetite, in presence of a suitable environment, induces hypo-tonus. Accumulation of waste products of metabolism in interstitial spaces, determines hyper-tonus. In the myocardium the myoblast is specialised in contractile faculty to its topmost bent, and secretes and holds in store an abundance of glycogen. Diastole is attended by selection of appropriate foodstuffs and food salts from the arterial stream and systole is determined through accumulation of waste products in interstitial spaces. These excreta are called, by certain writers, internal stimuli, for they excite the contractile impulse. When bodies unsuitable or noxious pollute the blood stream, hyper-tonus of the myoblast is determined. If unsuitable conditions of environment continue the protective phase of being becomes fully established and functional activities end.

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Section 2. *Pathological Processes.*

§2. Patho-
logical
processes.

DISEASE results from ordinary physiological processes occurring in constituent bioplasts of tissue in presence of persistent unsuitable conditions of environment and in accordance with modes of the protective phase. In presence of unsuitable conditions of environment the bioplast reduces absorptive and impressionable surfaces to the smallest dimensions possible and exudes formative plasma and plastids securing thereby a protective covering. When unsuitability continues formative plasma hardens and becomes horny or carbonaceous and a cystic envelope is formed. During the secretive period cell division occurs. These processes or certain of them are in operation in all forms of disease of tissues. Tissue bioplasts are units of structure and units of life hence they are units of protective action against disease. All processes of disease which modify structure result from operations of protective reflex function.

Faculties employed, are those of secretion of plasma and plastids, either innocent or toxic, and cell division. These faculties are observed in operation in all tissues in which disease processes are manifest. Tubercle is a prominent example. Tubercle consists of the agent of disturbance, namely, the bacillus tuberculosis surrounded by living or by dead tissue bioplasts. The living have practised or are still practising cell

division and secretion, for purposes of their own individual safety, while fallen ones lie poisoned by toxic exudations emanating from the invader or isolated from the blood stream they are suffering from starvation. The same fate has befallen tissue bioplasts stationed in sections of arterial walls upon which the syphilitic spirochete has made inroads. Cretaceous matter in lung and artery represents fragments of cyst wall built as a protective expedient against the invading enemy. Bioplast of connective tissue of liver, kidney, brain, spinal cord, and thelioblast, dermo-blast and osteo-blast alike are victims of syphilitic virus and sclerosis which attends syphilitic disease results from activities of unitary constituents of affected tissues which have practised cell division and have thrown out an abundance of formative plasma which afterwards hardening has given the tissue its sclerosed characteristics. Since connective tissue bioplasts are highly specialised in cell division and secretion of formative plasma they are active agents of sclerosis.

§2. Pathological processes.

The arteriolar wall thickened in the course of Brights disease is an example of cell division practised among its elementary units and of their exudative capacity in the presence of conditions of environment rendered unsuitable through pollution of the blood stream by waste products of metabolism. Hence the hyaline feature and hence the hypertrophy of the muscular coat. How the osteo-blast propagates its kind prodigiously and nests its progeny in a pool of formative plasma is observed in the constitution of callus which envelopes ends of fractured bones. Connective tissue bioplast, osteo-blast, thelio-blast and dermo-blast are specialists

§2. Patho-
logical
processes.

in faculties of cell division and formative plasma production consequently these tissues show greater marks of hyper-trophic change than others when their unitary constituents are exposed to influences unsuitable to the normal exercise of their peaceful activities. Hyper-trophy, development, and disease, alike represent processes set in motion with intention on the part of the constituent tissue bioplast to overcome adverse conditions of unsuitable environment.

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Chapter VI.

The Neuron.

Section 1. Evolution of the Protective Reflex Mechanism.

Section 2. Morbidity of Protective Reflex Centres, appropriately called segmentary Neurosis.

Section 1. *Evolution of the Protective Reflex Mechanism.*

IN the course of evolutionary progress, and before the installation of a central nervous system, a permanent visceral cavity is formed. In animals, so fashioned, receptive and protective functions are in operation. An example of these reflex activities is noticed in the sea anemone, a common object of interest at many seaside resorts. Pools at the foot of rocks left by receding tides are habitats of this primitive type of animal.

§1. Evolution of the protective reflex mechanism.

When conditions of environment are deemed suitable, anemone rises into columnar form, projects tentacles and opens wide its visceral cavity. If perchance an infantile mollusc be brought into touch with oral processes, it is seized,

{1. Evolution
of the protec-
tive reflex
mechanism.

interned, and soft parts are digested. At length through a convulsive and contractile impulse the empty shell is disgorged. The expulsive effort represents a passing protective phase, which, for a moment, closes the visceral cavity.

The protective phase is better marked when it comes into being during unsuitable conditions of environment. For instance when a storm is pending, and when short gusts of wind raise ripples on the pool, anemone retracts tentacles, expels gastric contents, closes the cavity and assumes a shrunken rounded form. While remaining in this phase, it is scarcely distinguishable from a tubercle on the rock or a pebble on the sea bed.

This example illustrates the fact that receptive and protective phenomena occur in multicellular organisms as well as in unicellular, that in both they are evoked by suitable and by unsuitable impressions and that functional processes through which they are engineered, are in both forms of organism, identical.

Later in the scale, when a rudimentary central nervous system is evolved, the same processes, induced by the same purposeful motives are operative. Still responses of a similar character are made to suitable and to unsuitable impressions. Examples of protective reflex activity are observed, when the common garden snail retracts tentacles and recedes under cover of its shell, when oyster and mussel tighten grasp on the valves of their shells, and when the limpet takes firmer hold on the rock. In each instance the reflex is excited under molestation. An apt example is noted when the common sea squirt named ascidian is touched, for

then it is seized with a contractile impulse which expels contents of the pharyngeal cavity.

§1. Evolution of the protective reflex mechanism.

In the last example the mechanism of the reflex through the instrumentality of which protective function is performed consists of two layers of contractile tissue a parietal and a visceral separated from one another by a peri-visceral space. The layers are anatomically and functionally connected by a neuronie reflex arc, the ganglion of which forming the keystone of the arc, is in touch with oral processes. In virtue of this mechanism unsuitable impressions impinging upon oral processes or upon any part of the visceral layer of contractile tissue sets the reflex into motion and as a result of co-ordinated activities of visceral and parietal layers, contents of visceral cavities are expelled. The primary purpose of the rudimentary nervous system exemplified in the ascidian would appear to be, to provide the mechanism, through which reflexes, acting in obedience to the law of adaptation, might continue operative.

This proposition is confirmed by the consideration that the evolution of a peri-visceral space divides the containing wall of the organism into two layers, a visceral and a parietal, and this prevents direct co-operation between constituent bioplasts of the original body wall as witnessed in the case of the sea anemone. The rudimentary central nervous system of the ascidian presents points of resemblance between it and a segment of the cord in man. The protective reflex mechanism of the ascidian is in touch with that disc of protoplasm which at a later stage of evolution becomes the organ of reason and sense and limbs of the reflex arc are planted in visceral and

parietal layers of contractile tissue. In the case of man, through an upper set of neurons, the segment of the cord is in touch with organs of reason and sense and the limbs of the segmental reflex arc, are planted in visceral and parietal layers of muscle. The purpose of the reflex in man as in the ascidian is to afford means of co-ordinative activities between visceral and parietal layers of muscle engaged in expulsion of contents of visceral cavities.

Every organism in the evolutionary scale possessed of visceral cavities is possessed also of a protective reflex mechanism whose function it is to empty them.

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Section 2. *Morbidity of Protective Reflex Centres, appropriately called Segmentary Neurosis.*

§2. Morbidity
of protective
reflex centres.

SEGMENTARY neurosis is the predisposing cause of many forms of spasmodic disorder, in which one or more functional centres lodged in affected segments take part in the production of symptoms. The gravity of the complaint is dependent upon the degree of intensivity of the neurosis and the office of centres affected by it. In certain instances, symptoms pass unnoticed, in others, they are sufficiently severe to startle, to alarm, or even to threaten life in the subject of them. The neurosis leaves no distinguishable marks recognisable at the autopsy.

A characteristic of the neurosis when of a functional type, that is to say, when not caused nor complicated by organic disease is, that at inter-paroxysmal periods, subjects of it feel quite well.

A very mild type of segmentary neurosis passes under the name of hysteria. In this instance, the uterus is primarily at fault. While segmentary neurosis is the cause immediately underlying symptoms, and therefore the predisposing cause of paroxysms, the uterus lies in the background as an efficient cause of the neurosis. The uterus, through the chain of sympathetic plexuses, hypo-gastric, aortic and solar, is linked up with great splanchnic nerves, and afferent muscle sensations from the cervix uteri impinge upon third, fourth, fifth, and sixth segments of the thoracic cord. When persistent and irritative, these musculo-sensory impressions are agencies of neurosis. Centres of the above-named segments come into our reckoning, because they innervate the thoracic mammary field, and because they give lodgment to roots of intercostal nerves, terminals of which are usually found tender in hysterical subjects.

Segments of the thoracic cord implicated in uterine disorders have important visceral connexions. In their neuronics are lodged efferent centres of heart, arteries, stomach, and of œsophagus. Consequently, palpitation, globus, and the "vapours," which are features common enough in hysterical symptomatology need no further explanation. The symptomatology of hysteria is sometimes distinguished by signs more tangible than subjective impressions. Adenoid lumps

§2. Morbidity
of protective
reflex centres.

§2. Morbidity of protective reflex centres. are found in mammary glands, and they occasionally appear at the close of catamenial periods. In several such instances

I have raised the outer border of the affected gland which covers linear points of outcrop of intercostal nerves, and have found these points of outcrop tender on pressure.

Among the most severe forms of segmentary neurosis are those resulting from toxic agencies; for instance, the segmentary neurosis of hydrophobia and tetanus. Pathognomonic marks giving envisagement to the neurosis are abundantly in evidence; integuments are tender, groups of parietal muscle are rigid and spasmodically inclined, and paroxysmal pain is agonising. Besides these marks are others belonging to the syndrome, namely, cardiac and vaso-motor disorder, secretory disturbance and spasm of muscles functionally associated with the visceral system; in tetanus those of the jaws, in hydrophobia those of the pharynx.

Tetanus and hydrophobia belong to the class of spasmodic paroxysmal disorders. Attacks are excited by psychological causes as well as by physiological and by physical. Mental and emotional disturbances excite attacks. They are excitable by the sight, smell, taste and ingestion of food, nay even by the bare thought of it. The psychological element looms large in many types of segmentary neurosis. Unreasoning fear of the anginous subject is an instance in point. It is not necessary for me to enumerate the list of paroxysmal spasmodic disorders connected with the alimentary canal and tubes and cavities associated with it in evolutionary history to prove the similitude, in their symptomatology, in their ætiology and in

their pathology which marks all. Holding a prominent place among the class of the segmentary neurosis is the angina pectoris. ^{§2. Morbidity of protective reflex centres.}

Organic disease, of investments of visceral organs, and their mesenteries, exerting traction or pressure upon the delicate network of sympathetic plexuses which ramify in subserosae of pericardial, plural, and peritoneal sacs, and also syphilitic and inflammatory and other irritative disorders affecting dendrites of sympathetic nerves; are efficient causes of the neurosis.

Among efficient causes of the neurosis may also be numbered calculi impacted at the neck of the gall or urinary bladder or ureter or urethra or aneurysms or new growths exercising pressure in any region of distribution of sympathetic nerves.

Whatsoever be the cause of segmentary neurosis, muscle sense is the sole efficient stimulus of paroxysmal seizures and the agency of pain. Pain is of three types, namely, direct visceral, diffused sympathetic, and deflected sympathetic. All types of visceral pain are referred, that is to say, pain generating impressions reaching the sensorium are referred to a peripheral source. Certain are referred to the organs whence they spring, others are referred after a diffusive fashion to distributary regions of sympathetic innervation. A third kind, namely, that of the deflected sympathetic type are referred to distributary branches springing from segments affected by the neurosis. This subject is treated more fully in the second chapter of this work.

Chapter VII.

Seats of Segmentary Neurosis.

Section I. *Connexions between the Sympathetic System of Nerves and the Spinal.*

§1. Connexions conceived by Hilton to be peripheral.

JOHN HILTON was the first observer to call prominent attention to surface pain resulting from visceral disease, but before 1863, when his lectures on rest and pain were published, parietal pain in visceral lesions was not unrecognised. Surgeons talked then as they had done for centuries before, of pain in the groin and testes, as a diagnostic sign of calculus in the ureter, and pain in the penis, when the stone had descended into the bladder. Physicians spoke then, as they do now, of surface pain and tenderness in biliary colic, in pericardial disease, and in aneurism. On one occasion, in the course of a clinical lecture on aneurism of the aorta, I well remember seeing Dr. Murchison marking out with a blue pencil the area of surface

pain incidence. Shoulder pain felt by persons suffering from "liver" attacks was then, as now, a matter of common remark.

§1. Connexions conceived by Hilton to be peripheral.

John Hilton explains these parietal phenomena as being due to the existence of connexions between visceral and spinal nerves; such connexion, he conceives, to be *peripheral*.* His view on this subject are expressed in chapter iv. of his well-known lectures on Rest and Pain, delivered in 1861 and 1862, and published in 1863.

In illustration of these connexions, he explains shoulder pains in association with abdominal visceral disturbance as resulting from "*transmission*"* of an "*influence*"* from great splanchnic nerves to fourth, fifth, and sixth dorsal nerves. "*Without going into the question of how the transmission is made,*"* he remarks, "I think it likely that the pains which persons experience in disease of these viscera may be explained by the relative position of the great splanchnic nerve communicating, on the one hand, with the solar plexus and thence with these digestive organs, and on the other, "*distributing its branches to the fourth, fifth, and sixth dorsal nerves.*"*

The term, "*transmission,*"* employed in the context, is consistent with the anatomical description. I find nothing in the context, nor in his account of examples to alter the conclusion that he regarded connexions between sympathetic and spinal systems of nerve as peripheral.

Following on, Mr. Hilton introduces cases of spinal disease and a case of aneurism. In his two cases of spinal disease, pain was suffered at the pit of the stomach, and

*Italics are mine.

§1. Connexions conceived by Hilton to be peripheral.

in both a history of gastric disorder was mentioned. Yet in neither, does John Hilton speak of central nervous implication, as accounting for gastric symptoms. On the contrary, in one of the cases, evidence bearing upon this point is brushed aside with the remark. "Observing that the tongue and other circumstances did not indicate much serious disturbance in the neighbourhood of the liver, stomach, duodenum and other parts in that locality," it was suggested that "there might be something amiss with the spine." In both instances, a lesion between sixth and seventh vertebræ was found. Concluding his descriptive account, Mr. Hilton makes the following significant statement: "If a patient complains of pain on the surface of the body, it must be expressed by the nerve which resides there, there is no other structure that can express it, and *somewhere in the course of its distribution, between its peripheral termination and its central spinal or cerebral origin,** the precise cause of the pain expressed on the surface must be situated."

This last phase is not open to misconstruction. It cannot, in grammar, nor in logic, be read as implying a central lesion. If John Hilton had meant central lesion, it is inconceivable that he did not say so. Therefore, I conclude that John Hilton's conception of the nature of connexions existing between sympathetic and spinal nerves is that they are *peripheral.**

Extract from first edition of John Hilton's lectures on rest and pain, p. 64, 1863.

*Italics are mine.

“Sympathetic pains on the surface of the body connected with derangements of internal viscera are of great and pressing interest to us. I conceive that pains situated on the surface of the body and associated with something grown in an internal viscus, must be looked upon as a beneficent provision enabling us, by external pain, to receive the information, and to appreciate slight organic changes or derangements of function of the internal viscera.”

§1. Connexions conceived by Hilton to be peripheral.

“Perhaps one of the most frequent of the sympathetic pains is that which occurs between the shoulders, or over the inferior angles of the scapulæ. This pain must be connected with the distribution of some of the spinal nerves, because no other structures could express the pain, and no other nerves occupy the position except the fourth, fifth and sixth dorsal nerves, which are distributed over the inferior angles of the scapulæ, and interscapular space. Hence, we must conclude that these nerves are the immediate seat of pain. If we trace internally the great splanchnic nerve from within the thorax downwards, and find it connected at its abdominal end with the solar plexus, thence trace its distribution to the stomach, duodenum, liver and pancreas; and if we follow the other or upper end of the same great splanchnic upwards to the fourth, fifth and sixth dorsal nerves, which give peripheral sensitive filaments to the integuments over the angles of the scapulæ, to the interscapular spaces and the adjoining skin, we can well imagine, without going into the question of how the transmission is made, that these nerves carrying the influence upwards and backwards may explain the occurrences of the

§1. Connex-
ions conceiv-
ed by Hilton
to be peri-
pheral.

pains sometimes experienced in those external parts, associated with abdominal visceral disturbance. I think it likely then that the pain which persons experience in disease of these viscera may be explained by the relative position of the great splanchnic nerve communicating on the one hand with the solar plexus and thence with these digestive organs and on the other, distributing its branches to the fourth, fifth and sixth dorsal nerves."

Several cases in illustration and a concluding remark follow:—

"Mr. Ray of Durwich, brought me a boy eight years of age who had been suffering from severe pain just above the pit of the stomach and who used to walk about with his hands placed over that region with the body a little inclined forward as if suffering from some irritation or pain of the abdominal organs in which direction the treatment had hitherto been chiefly applied but without much benefit. It was noticed that the pain increased during the maintenance of the erect posture, and that it was relieved by the recumbent position. The child was old enough to express a little of what he felt when asked where he had previously complained of pain and we observed that the pain was expressed on both sides alike. I requested that he might be undressed so that we might be able to examine his spine. We then found that there was disease with slight displacement between the sixth and seventh vertebrae, and pressure upon these vertebrae produced the pain in front. The real cause of this child's symptoms was now apparent."

"About two years ago Dr. Addison was requested to see a gentleman's son who was then at the Westminster School, and who it was thought had been suffering from something wrong in his abdomen, for he had pain at the pit of the

stomach and occasional vomiting. Observing that the tongue and other circumstances did not indicate much serious disturbance in the neighbourhood of the liver, stomach duodenum and other parts in that locality, he suggested that there might be something amiss with the spine. I found that he had precisely the same pains as those observed in Mr. Ray's case over the pit of the stomach, and that he was easy when lying in bed. We believed we recognised disease of the spine exactly between the sixth and seventh dorsal vertebræ. All stomach medicines were entirely put aside. He was made to lie down on a bed, sofa or couch for two or three months, and from that time he got perfectly well. It was clearly a pain dependent upon a cause situated remotely from the point of manifestation. Tracing the pain backwards we came to the seat of the disease, and then by adopting rest as an agent, the boy was ultimately cured."

§1. Connexions conceived by Hilton to be peripheral.

"Sometime since," continued Mr. Hilton:—

"I saw a gentleman who was brought to me by a surgeon complaining of something wrong in his back. I was not told what it was, but was requested to examine him. I asked the patient whether he felt any pain. He said 'Yes, I have pain hereabouts,' pointing to the distribution of the fourth and fifth dorsal nerves on the chest. The pain was one-sided only—not symmetrical which led me to conclude that the cause was one-sided. On tracing the posterior course of the fourth dorsal nerve towards the spine, I recognised a distinct aneurismal bruit. This led me to conclude as a physician had done before, that the patient was subject to aneurism. I mention this case not for the purpose of prolonging or parading unduly the subject, but merely to show what precision this method of examination gives."

"If a patient complains of pain on the surface of the body, it must be expressed by the nerve which resides there, there is no other structure that can express it, and somewhere in the

course of its distribution between its peripheral termination and its central spinal or cerebral origin the precise cause of the pain expressed on the surface must be situated."*

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Section 2. *Central Connexions between the Sympathetic and Spinal Systems of Nerves.*

§2. Central connexions.

RECENT views on visceral symptomatology, including visceral referred pain and tenderness are based on the hypothesis of the existence of central connexions between the sympathetic and spinal systems of nerves. This hypothesis is ascribed by Sir James Mackenzie in his work on Interpretation of Symptoms to Ross, whose paper on the subject appeared in "Brain" in 1888. Other leaders of opinion and writers assert that central connexions between the two systems of nerves were discovered by John Hilton, and were described by him in his lectures on Rest and Pain. For instance, in his Goulstonian lectures on the Sensibility of the Alimentary Canal, Dr. Hertz takes this view.

The following words appear in the published reports:—

"Although MacKenzie was the first to suggest that all pain in visceral disease is really felt in superficial structures, the idea of referred pain was not new. In the first edition of his lectures on rest and pain, published in 1883, Hilton discussed the origin of the sympathetic pain which he described as occurring on the surface of the body in association with derangements of internal and often remotely situated viscera. He suggested

* Italics are mine.

that the superficial pain is due to *some central connexion* of the visceral sympathetic nerves, with the peripheral spinal nerves, a connexion which was subsequently more closely studied by Verdon in 1874. In 1888, Ross investigated the question afresh. He explained the existence of somatic pain in much the same way as Hilton had explained it under the name of sympathetic pain.”*

§2. Central connexions.

For the moment I am not concerned with Ross's views, because his article appeared fourteen years later than my own. As far as I am aware, my article came first among the series written on this subject; authors of which had since adopted views corresponding with mine. In order that readers shall be in a position to judge for themselves as to the truth or error of Dr. Hertz's version, I subjoin extracts pertinent to the subject from my own paper.

In my article appearing in St. Thomas's Hospital Report, 1874, the following description of central connexions is given:—†

“In the medulla and cord there are many groups of ganglionic cells, each group presiding over a certain set of muscles, or other structures, and each having definite sets of fibres which bring it into relation with other parts of the system.

(a) with the brain

(b) with the part over which it presides

(c) with a corresponding group of ganglionic cells on the opposite side

(d) with other ganglionic groups.

Besides these connexions, the individual cells which

*In reference to this statement, and a few days later, Sir James MacKenzie wrote:—“I do not think that Dr. Hertz has quite understood the spirit of your work, nor of Ross's, nor of Hilton's. Hilton's book is a most interesting one, but it is merely a collection of isolated facts and with only a very dim perception of the mechanism by which pain is produced.” And again he writes, “In the second edition of my book on symptoms I shall refer to your anticipations of the views of Ross and others.”

†Report, pp. 353 and 354.

§2. Central
connexions.

compose the groups communicate one with another. So all nerve filaments from such a centre, by virtue of this intimate cell communication, are influenced by a stimulus reaching any one part of the same group of cells."

*"Certain branches of the sympathetic have in their distribution a definite relation to cerebro spinal nerves arising from the same region."**

"The sympathetic consists of two symmetrical chains of ganglia, each ganglion communicating with the one above and the one below it, and each corresponding with a cerebro spinal nerve, and although in the neck we find only three ganglia these correspond to the eight cervical and three cranial nerves, and may be looked upon as so many ganglia which have become incorporated together. *Each ganglion has a communication with the spinal cord at the root of its corresponding spinal nerve and each gives off arterial and visceral branches.*"

"Let us first examine what connexion vaso-motor nerves have with the sensory nerves of the same region."

"The sensory nerves of arm are derived from fifth, sixth, seventh and eighth cervical and the first dorsal nerves, together with a communication from the cervical nerve."

"The vaso-motor nerves of the arm are derived from the second and third cervical and first dorsal ganglia, *these having communication with the cord at the roots of the fifth, sixth seventh and eighth cervical and first dorsal nerves, together with a branch from the lower part of the first cervical ganglion, or from the part corresponding with the fourth cervical nerve,*

*Report p. 360. NOTE—Italics not in original context.

so the origin of the vaso-motor nerves of the arm corresponds to the origin of spinal nerves of the arm." §2. Central connexions.

"A like relation in supply and origin may be found in the leg. Lumbar ganglia receive a number of branches from the cord and supply the aorta and iliac arteries. This plexus of vaso-motor nerves is continued down on the femoral and all its branches. *From the same part of the cord the limb is supplied with spinal nerves.* The great sciatic as well as the anterior crural and cutaneous nerves leave the cord as a leash at the lower border of the first lumbar vertebra and then proceed to the limb. This correspondence of distribution of vaso-motor and spinal nerves may not only be demonstrated in the limbs, but over the trunk. *The vaso-motor nerves of intercostal arteries arise from the cord at the same place as intercostal nerves and their distribution is much alike.* The diaphragm receives its nerve supply from the upper part of the cord through the phrenic; its vaso-motor from the same region along the internal mammary. The face is supplied with sensation by the fifth. The superior cervical ganglion receives a communication from the fifth and gives vaso-motor nerves to the facial artery."

"These examples are sufficient to show that a resemblance exists between the spinal and vaso-motor system in their origin and supply, and *it is probable that the spinal and vaso-motor nerves of a part always originate in the same region of the cord.* This is borne out by the fact that injury of the

§2. Central
connexions.

nerves of a part may interfere with its nutrition and cause atrophy."

"The remaining branches of the sympathetic ganglia are distributed to the viscera, and *these also appear to have a certain relation with the spinal nerves, which are derived from the same region of the cord.* The spinal nerves supplying the surface and the sympathetic the viscera beneath the surface.* For example, the heart and lungs have their sympathetic supply principally from the cervical ganglia, and, therefore, from the cord in that region. The descending branches of the superficial cervical plexus; the respiratory and the thoracic supplying the surface of the chest arise from the same part. The surface of the abdomen is supplied in great part by the six lower intercostals, and we also find the great splanchnic arising in the dorsal region, principally from the sympathetic ganglia in connexion with the roots of these six lower nerves, and passing down to supply the viscera of the abdomen. The upper part of the bladder has its supply from the hypo-gastric plexus, and, therefore, from the lumbar ganglia; the corresponding part of the wall of the abdomen is supplied by the ilio-inguinal and ilio-hypo-gastric nerves, which arise from the same part of the cord."

The article from which these extracts are taken is reproduced in its entirety below.

*Report p. 362.

NOTE—Italics not in original context.

Section 3. *Inter-communication of Nerves and the
Physiological advantage gained thereby.**

IN the following observations I have wished to draw attention to the inter-communication of nerves, sometimes evident to the naked eye, sometimes rather assumed than proved, and the inter-dependence of parts in consequence.

§3. Original article, 1874 showing central connexions and protective reflex activities.

The facts upon which such a subject must be founded, can, I think, be grouped together, so as to present three propositions:—

1. That structures bearing a functional relation to one another are generally supplied by the same nerve.

2. That in regard to parts thus related, though not supplied by the same nerve, communications are often established between their respective cerebro-spinal nerves through ganglia.

3. That certain branches of the sympathetic have, in their distribution, a definite relation to that of the cerebro-spinal nerves arising from the same region.

1. Structures which bear a functional relation one to another are generally supplied by the same nerve.

The third nerve by its upper division supplies the levator palpebræ, the lower through the lenticular ganglion, the circular muscle of the iris. In the normal condition, when the eye is closed and the pupil remains in a state of dilatation,

*Article reprinted from St. Thomas's Hospital Reports, 1874, by Walter Verdon, F.R.C.S., Medical Registrar at St. Thomas's Hospital, and Demonstrator of Anatomy at Westminster Hospital.

§3. Original article, 1874 shewing central connexions and protective reflex activities.

a stimulus acting at the nucleus of the third nerve, which would cause the elevation of the lid, may also have an effect upon the sphincter of the iris, and so prevent any sudden light damaging the delicate structure of the retina.

In the nervous supply of the muscles of the eye, there seems, at first sight, to be some other principle of arrangement than that laid down at the heading of this part of the paper, for corresponding muscles do not act together. But on more closely examining the subject, the apparent exception can be seen to be no real exception at all. It must be borne in mind, that in the medulla and cord there are many groups of ganglionic cells, each group appearing to preside over a certain set of muscles or other structures, and each having definite sets of fibres which bring it into relation with other parts of the system—(a) with the brain; (b) with the part over which it presides: (c) with a corresponding group of ganglionic cells on the opposite side; (d) with other ganglionic groups. Besides these connections, the individual cells which compose the groups communicate one with another. So all nerve filaments from such a centre (by virtue of this intimate cell communication) will be influenced by a stimulus reaching any one part of the same group of cells. And the extent of bilateral action of the parts supplied by these filaments will vary in proportion to the closeness of connection of the corresponding groups.

The nuclei of the *motores oculorum* are so closely connected that they almost blend one into the other across the median line; so that we should expect to find the eyes moving much in consort, and such is really the case in the vertical plane and in the movements of the lids. It is quite impossible to look upwards or downwards with one eye without moving the other in a like direction; it is also difficult to open one eye and keep the other shut. The movements in the horizontal plane are more complicated, the internal rectus of the one side

acting with the external of the other. The motores (third) decussate at their roots, but the nerve to the external rectus (sixth) arises at the same side as the muscle which it supplies.

§3. Original article, 1874 showing central connexions and protective reflex activities.

The nuclei of the abducens (sixth) have no communication with one another across the median line, neither do the muscles which they supply act together. But the nucleus of the left motor oculi lies on the right side of the medulla, and the nucleus of the right abducens lies on the same side. The roots of the left abducens and the right motor oculi will both be found on the left side. This may, in some measure, account for the combined action of the internal rectus of the one side and the external of the other. And by reason of the decussation which occurs in the optic commissure, the outer half of the retina of the right eye, and the inner half of the left, receive nerves from the right optic tract, and *vice-versa*.

The unity of supply to parts connected with the same function is illustrated in the fifth nerve, in mastication.

The food first comes into contact with the lips, which are supplied by this nerve. It is next taken between the teeth, which, together with the muscles which move the jaw, and the articulation of the jaw, have supply from the same source; thirdly, the food passes into the cavity of the mouth, and is bathed in saliva from the sub-maxillary glands. The tongue, the hard palate, the gums, and the gland, all receive branches from this fifth nerve.

The food then passes on, and lies between the base of the tongue and soft palate, and saliva is poured upon it from the parotid gland; the base of the tongue is at the same time drawn upwards and backwards by the palato-glossi muscles.

At this stage the glosso-pharyngeal nerve plays the principal part, and we will look to the distribution of this nerve.

The main branches supply the base of the tongue, branches supply the tonsils and soft palate; others join the

§3. Original article, 1874 shewing central connexions and protective reflex activities.

carotid plexus and pass up to the paratid gland; and lastly, a branch joins the great petrosal to proceed with it to Meckel's ganglion. As the palato-glossi muscles receive supply from Meckel's ganglion, we may infer that their action is influenced by this ganglionic branch, and that the food lying between the base of the tongue and the soft palate (both being supplied by filaments from this nerve) would alike influence the action of these muscles and the flow of saliva from the parotid gland.

The nucleus of the seventh nerve lies very close to that of the fifth, and is connected with it.

The fifth nerve supplies the lachrymal gland and conjunctiva, the seventh the orbicularis, and this connection of supply has a protective influence over the conjunctiva; if a piece of dust falls upon it, the eye is closed to prevent further injury from outside, and there is an attempt to wash away the particle by a flow of tears.

The outer side of the foot is supplied by the external saphenous nerve—a continuation from the great sciatic—and the hamstrings from the main trunk of the same nerve.

The skin on the radial side of the palm and fingers is supplied by the median, that on the ulna side by the ulnar nerve, and the same applies to the flexors of the two sides (so in the event of an object being grasped, the area of skin brought into contact with it, and muscles engaged are associated in action through innervation by the same nerve.)*

The genito-crural nerve sends one branch to the inner side of the thigh, another to the cremaster muscle.

In the male child the relation which these two parts of the same nerve bear to one another may be well seen by stimulating the branch to the thigh. The cremaster by this means is set into action, and the testicle is drawn up and again let fall when the stimulation ceases.

* Sentence in brackets omitted from the early copy.

The lower part of the rectum receives filaments from the branches which pass to the sphincter; the lower part of the bladder and its neck are supplied with branches from the same source.

§3. Original article, 1874, showing central connexions and protective reflex activities.

In defecation, when all the nerve energy of the cord is directed into one channel, namely, in those nerves which would cause contraction of the rectum, the sphincter ani, and often also the sphincter of the bladder, relaxes (both supplied by the internal pudic nerve), and urine may involuntarily pass with the effort to void the fæces, and not by contraction of the muscular coat of the bladder.

The intimate connection which exists between the corresponding nerve roots of both sides of the body is seen, not only in the tendency to symmetrical action of the various sets of muscles when excited to action by the brain (as both sides of the tongue in speaking and swallowing, and both sides of the face in laughing), but also when the stimulation occurs at the periphery, as the stimulation of one foot in hemiplegia may cause movements of the other, and an aneurism of the aorta pressing on one recurrent laryngeal nerve only, may affect the muscles of both sides of the larynx.

That disease of one part of the distribution of a nerve may affect the remainder of its distribution is, I think, not at all unlikely if disease of the nerve of one side may affect the corresponding on the other side of the body.

A child was brought to me suffering from excessive flow of tears and photophobia of the right eye. I found at that time nothing to account for these symptoms, and requested the mother to let me see the child in a few days. I saw her again: the eye was perhaps worse than before—certainly not better. I examined the child's mouth and found the upper gum on the right side very tense and painful. I directed my attention to the treatment of this part, and in a few days the irritation had subsided and the eye was perfectly well.

The fifth nerve supplies the gums, and it supplies the lachrymal gland and eye with sensibility. Here irritation of the second division appeared to affect seriously the function of the first division of this nerve; and may not the disorder of the stomach which takes place in phthisis be due to the implication of branches of the vagus distributed to the lungs?

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Section 4. *Short Circuit Reflex Protective Activities for Organs of Special Sense.*

§4. Short circuit reflex protective activities for organs of special sense.

IN regard to parts functionally related though not supplied by the same nerve, communications are often established between respective cerebro-spinal nerves by means of ganglia.

There are nerves which, by means of ganglia connected with their trunks, communicate definitely and constantly with other nerves in their neighbourhood. We find ganglia connected with certain nerves, and from the regularity and constancy of their communication we are led to believe that they serve some important office in the animal economy.

The organs of special sense appear to be, in a measure, protected from injury by means of ganglia in connection with their nerves. The auditory nerves send branches which follow the facial nerve into the fallopian canal, and these enter into the ganglion or its trunk. From this the small petrosal is given off to supply the tensor tympani through the optic ganglion; it then sends a branch to the stapedius.

Here we see that the nerve which supplies the internal ear and endows it with a special sense has communication

through a ganglion with those muscles which have the power to moderate the effects of sound upon its delicate and easily injured parts. Upon any sound breaking suddenly on the ear the tympanic membrane is rendered at once tense and unyielding, placing a barrier against an undue amount of vibration, and the stapedius, tilting out the base of the stapes, prevents compression of the contents of the vestibule.

§4. Short circuit reflex protective activities for organs of special sense.

In connection with this intermesentia ganglia-formis are also branches which supply the external ear. Although these are of little importance in man, one can easily understand the advantage of a direct communication between the auditory nerve and the muscles of the external ear in those animals which use these muscles constantly to collect sounds from varying directions.

The tongue, the organ of taste, is in like manner protected by the communication of the gustatory with the sub-maxillary ganglion. If some injurious substance comes in contact with the tongue by means of this connection, the salivary glands pour out their secretion upon it, and by diluting and separating it from the surface protect the tongue.

The retina is protected by the sphincter iridis receiving supply from the third nerve, and the levator palpebræ having a like supply as already referred to, another nerve also takes part in the protection of this organ. The fifth nerve supplies the eye with common sensibility, and, I think, we have reason to believe that it is sensible to light. We know that a strong light may cause sneezing, and this complicated action could only take place through this great reflex nerve, no other nerve in the neighbourhood having the necessary connection to perform this function.

The lenticular ganglion receives branches from the fifth and also from the third nerve. A number of branches are given off from its anterior part which pierce the sclerotic and pass on to the iris. If then these branches of the fifth nerve

are susceptible to the influence of light, their connection with the motor iridis in the ganglion would give the retina a ready protection from the damaging effects of strong light.

By means of these several ganglia here referred to, the organs of special sense are endowed with the power of self-protection, and thus their preservation is not dependent on the integrity of a higher centre.

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Section 5. *Central connexion between Vaso-motor and Spinal Nerves.*

§5. Central connexions between vaso-motor and spinal nerves.

CERTAIN branches of the sympathetic have in their distribution a definite relation to that of the cerebro-spinal nerves arising from the same region.

The sensory nerves of the arm are derived from the fifth, sixth, seventh and eighth cervical, and first dorsal nerves, together with a communication from the fourth cervical nerve.

The vaso-motor nerves of the arm are derived from the second and third cervical and first dorsal ganglia, these having communication with the cord at the roots of the fifth, sixth, seventh and eighth cervical, and first dorsal nerves, together with a branch from the lower part of the first cervical ganglion (or from the part corresponding to the fourth cervical nerve). So the origin of the vaso-motor nerves of the arms corresponds to the origin of the spinal nerves of the arm.

A like relation in supply and origin may be found in the leg. The lumbar ganglia receive a number of branches from the cord and supply the aorta and iliac arteries; this plexus of vaso-motor nerves is continued down on the femoral and all

its branches. From the same part of the cord the limb is supplied with spinal nerves. The great sciatic as well as a leash at the lower border of the first lumbar vertebra, and thence proceed to the limb.

§5. Central connexions between vaso-motor and spinal nerves.

This correspondence of distribution of vaso-motor and spinal nerves may not only be demonstrated in the limbs, but over the trunk.

The vaso-motor nerves of the intercostal arteries arise from the cord at the same place as the intercostal nerves, and their distribution is much alike.

The diaphragm receives its nerve supply from the upper part of the cord through the phrenic; its vaso-motor from the same region along the internal mammary.

The face is supplied with sensation by the fifth; the superior cervical ganglion receives a communication from the fifth, and gives vaso-motor nerves to the facial artery.

These examples will be sufficient to show that a resemblance exists between the spinal and vaso-motor systems in their origin and supply, and it is probable that the spinal and vaso-motor nerves of a part always originate in the same region of the cord. This is also borne out by the fact that injury to the nerves of a part may interfere with its nutrition and cause its atrophy.

When, for instance, a nerve is implicated in the cicatrix of a stump, we may often find the muscles and other structures of the part speedily undergoing degeneration, a conical stump being the result; and in spinal and hip-joint disease how quickly the limb wastes—more quickly, I think, than can be accounted for by the waste, which is the concomitant of inaction—more likely by implication of nerve-fibres.

Section 6. *Central Connexions between Visceral
Sympathetic Nerves and Spinal.*

§6. Central
connexions
between
visceral sym-
pathetic
nerves and
spinal.

THE remaining branches of the sympathetic ganglia are distributed to the viscera, and these also appear to have a certain relation with the spinal nerves which are derived from the same region of the cord, the spinal nerves supplying the surface, and the sympathetic the viscera beneath the surface.

For example, the heart and lungs have their sympathetic supply principally from the cervical ganglia, and therefore from the cord in that region. The descending branches of the superficial cervical plexus, the respiratory and thoracic supplying the surface of the chest, arise from the same part.

The surface of the abdomen is supplied in great part by the six lower intercostals, and we also find the great splanchnic arising in the dorsal region principally from the sympathetic ganglion in connection with the roots of these six lower nerves and passing down to supply the viscera of the abdomen.

The upper part of the bladder has its supply from the hypogastric plexus, and therefore from the lumbar ganglia the corresponding part of the wall of the abdomen is supplied by the ilio-inguinal and ilio-hypogastric nerves which arise from the same part of the cord.

This correspondence of supply of the surface with that of the viscera is, I think, important. In applying applications to the surface of the thorax or abdomen over a viscus a reflected influence may be communicated through the nerve-centre to that organ.

Appendix II. Other Papers.

The Jugular Pulse.*

OBSERVATIONS made below on the deflections of ^{The jugular} the jugular curve may prove of interest to readers ^{pulse.} who, like myself, are following Dr. James Mackenzie's methods of clinical cardiography.

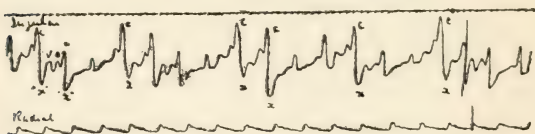
The c wave.—The absence of a dicrotic appendage from the *c* wave is proof that this wave is not the product of an ordinary arterial impression. On anatomical grounds alone it cannot be said to take its origin from carotid pulsation because, below the sinus, vein and carotid artery do not lie in contact, but are separated from one another by an interspace-giving room for the lodgment of the vagus nerve. The wave might be regarded as resulting from pulsation of the subclavian or innominate arteries, but here again the absence of dicrotic appendage creates difficulty. On the other hand, relationship between venous and arterial columns is intimate in the

* Reprinted from *Lancet*, January 25th, 1913.

The jugular
pulse.

neighbourhood of the aortic arch. The vena cava superior, conducting blood to the auricle from its tributaries in the neck, lies in touch with the ascending limb of the aorta, and embraces it on its posterior and right lateral aspects. During the sphygmie period, elongation of the arterial arch takes place, and elongation is followed by recoil. This lurch of the aorta, which is additional to pulsatory phenomena, common to all arteries, cannot fail to be instrumental in transmitting an impulse to the venous column, and, the resulting wave must necessarily consist of simple positive and negative curves unattended by any dirotic encumbrance. It is therefore suggested that the aorta is the source of origin of the *c* wave. (See Fig. 1.)

FIG. 1.



The declivity of the *c* wave is noticed in the above curve as descending to the fundus of the *x* depression unattended by a dirotic appendage.

X and *y* depressions, and *v*, *a*, and *c* eminences.—Depression *x* occupies a prominent place in the jugular curve. It extends to a lower plane in the normal tracing than that attained by any other deflection, a fact indicating that here auricular pressure reaches its extreme limit of minus quantity. It is a landmark separating the territory of a cyclic period from that which precedes and that which follows it. It records the fraction of time when a period is closing with the

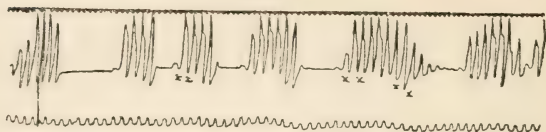
end of ventricular systole and when another period is opening with the beginning of ventricular diastole, consequently an alternating series of x depressions and triple waves is the distinguishing feature of the jugular curve. (Fig 1.)

The figure occupying the cyclic period of the tracing and extending from the fundus of one x depression to the fundus of the next, although bearing the semblance of a triple wave, is in reality a simple curve deflected as its apical part by the upheaval of eminences usually differentiated by symbols v , a , and c . In the case of normal and slow pulses this simple cyclic wave is bisected at a point lying between v and a eminences by the interpolation of the y depression. But the y depression is not a constant feature. When pulsation rises above the normal beat-rate it appears only as a mere indentation of the curve, and when pulsation still further quickens it becomes entirely obliterated, leaving no trace of its presence behind.

Fig 2 represents the curve of a very rapid pulse from which the y depression is absent. Figs. 3, 4, and 5 show the evolution of the y depression as the pulse slows down. In Fig. 3 it appears as a mere indentation interposed between the eminences v and a at the apical part of the cyclic wave. In Fig. 4, representing a pulse of normal rate, this depression splits the cyclic wave except at the basal part, forming two distinct undulations v and a . Fig. 5 represents a pulse of 35 beats a minute. The y depression completely bisects the cyclic wave and extends even below the plane of the x depressions which fix the limits of the cyclic period.

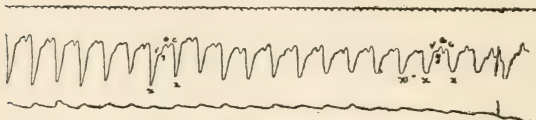
The jugular
pulse.

FIG. 2.



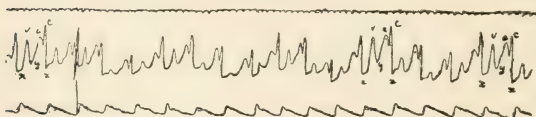
Pulse-rate 210. The upper curve is jugular, the lower radial. Symbols *x x* mark the limitations of the cyclic wave, which consists of a simple upstroke and downstroke. The upstroke of the cyclic wave corresponds with the period of ventricular diastole, the downstroke with that of ventricular systole.

FIG. 3.



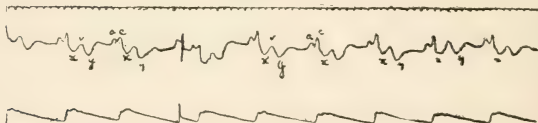
Pulse-rate 85. The upper curve is jugular. Symbols *x x* mark the limitations of the cyclic wave. Depression *y* appears as a notch between the eminences *v* and *a*.

FIG. 4.



Pulse-rate 66. The upper curve is jugular. Symbols *x x* mark the limitations of the cyclic wave. Depression *y* splits the cyclic wave into two parts except at its basal zone.

FIG. 5.



Pulse-rate 35. The upper curve is jugular. Symbols *x x* mark the limitations of the cyclic wave. The *y* depression is broad and wide, and completely bisects the cyclic wave, lending to the curve the semblance of duality.

The y depression cannot, therefore, be regarded as representing a process in the cardiac syndrome essential to the maintenance of the circulation. It is caused by a momentary fall in intracardiac pressure when the muscle forming the wall of the right ventricle becomes attenuated by relaxation, and hence more open to the influence of aspiratory energy lodged in the media of the heart's environment. The jugular pulse.

Eminences v , a , and c also represent processes in the cardiac syndrome which are not essential factors in the upkeep of the circulation. V appearing at an early stage of diastole is formed by the recoil of the a - v . septum, a by auricular systole, and c by an impulse communicated to the venous column from the aorta.

The solitary jugular cyclic wave.—Having now given consideration to the y depression and to the upheaval of the v , a , and c eminences, which in turn deflect the curve of the solitary wave from its simple course, we must now enter upon a survey of the processes determining the rise and fall of the solitary wave itself. These processes, it will be observed, constitute the essential forces of the circulation.

The pericardial sac consists of a tough, inelastic, fibrous membrane attached below to the aponeurosis of the diaphragm, above to the roots of the great vessels entering and leaving the heart, and in front to the upper and lower ends of the sternum. It serves the purpose of preventing undue expansion of the walls of the cardiac cavities under the aspiratory influence of intrathoracic negative pressure, which is never less in quantity than minus 8 mm. Hg., and

The jugular
pulse.

sometimes attains a degree of elevation represented by minus 30 or 40 mm. Hg.

During systole the cone of the heart descends, drawing down with it the floor of the auricles, and occupies a restricted space at the fundus of the pericardial sac. The venous column engaging the right auricle and filling the great veins entering this cavity also falls to a lower plane than that previously occupied by it, and is thus more fully exposed to the influence of a pressure environment. Thus the declivity of the solitary jugular cyclic wave runs synchronously with ventricular systole.

At the end of systole diastole begins. The cone of the heart expands, pushing backwards the *a.-v.* septum and occupying the pericardial sac almost to its full capacity. Since the tricuspid valves open towards the ventricle, they float with the blood stream and oppose no obstacle to its entrance; moreover, the opening of these valves causes no deviation in intracardiac pressure. Consequently, during the period of diastole auricle and ventricle constitute a single chamber in which pressures become instantly equalised. The inflowing venous stream, which gradually fills this single cardiac chamber and afterwards backs itself up in the tributary veins, neutralises intracardiac minus pressure, converting it to a positive quantity, and thus causes a steady rise in venous pressure.

In the jugular curve, when the pulse-rate is above 80, very little is noticed of the *y* depression, because the volume of the incoming stream is more than sufficient to keep pace with the

relaxation of the ventricular wall, and because ventricular systole begins while auricular pressure is still rising; consequently the acclivity of the solitary jugular curve runs synchronously with ventricular diastole.

In the slow pulse, however, in which case diastole is prolonged, the wall of the ventricle becomes attenuated by extreme relaxation, and hence it is particularly open to the influence of aspiratory energy lodged in the media of the heart's environment. As a result minus pressure asserts itself in the auriculo-ventricular cavity, and is recorded by a negative deflection of the jugular curve recognised in depression *y*.

If deflections which do not represent processes essential to the maintenance of the circulation be eliminated it is noticed that the positive curve of the venous pulse is coincident with the negative curve of the arterial pulse, and that the fall of the venous cyclic wave is contemporaneous with the rise of the arterial.

The jugular curve, then, consists of a sequence of cyclic waves arising from the interaction of two forces in the presence of limitations imposed by the pericardial sac. One of these forces consists of negative pressure lodged in the media of the cardiac environment, the other is exemplified by ventricular systole. These potential and these kinetic energies are engaged in filling and emptying the ventricles.

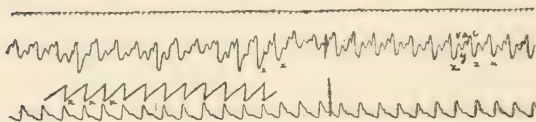
The effect upon the venous column resulting from the exercise of these energies is manifested by the appearance of a solitary wave occupying the entire cyclic period of the

The jugular
pulse.

jugular pulse. When the jugular pulse is synchronised with the radial the trend of pressures, as indicated by the curves, is identical, except that they exist in inverse order of incidence. (Fig. 6.)

The respiratory curve.—The wide deflection of the jugular curve, which includes a sequence of many cyclic periods, results from the rise and fall of negative pressure in the

FIG. 6.



Tracing of jugular and radial pulses. Interpolated between them is a diagrammatic curve illustrating the trend of venous pressure uninfluenced by minor circulatory processes.

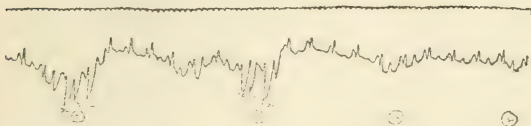
thoracic cavity coincident with inspiration and expiration; ordinary or normal respiration produces a shallow deflection, gasping or forced respiration a deep one. Negative pressure in the thoracic chamber is maintained by sustained tension of the elastic fibre of the lungs, tautness of the bony and cartilaginous framework of the thoracic wall, tonus of inspiratory muscle, and integrity of pleural cavities.

During normal inspiration the gradient of intrathoracic negative pressure rises to minus 30 mm. Hg. During ordinary expiration and the pause succeeding it the gradient falls to minus 8 mm. Hg. During forced or gasping respiration the range of negative pressures reaches wider proportions, attaining minus 40 or 50 mm. Hg. during inspiration. The greater width of range is induced almost solely by depression of the

aponeurosis of the diaphragm, which while normal respiration is continued maintains a stationary plane. The jugular pulse.

Depression of the aponeurosis of the diaphragm has a particular effect on the jugular curve, as observed in Fig. 7. With the descending aponeurosis, the pericardial sac is drawn down, and together with this structure the heart and superior cava. As a result of the fall of the pericardial sac to a lower plane, an extended area of the auricular and venous walls and

FIG. 7.



The inspiratory deflections of the curve (*a*) and (*a*) are marked by deep *x* and *y* depressions resulting from descents of the aponeurosis of the diaphragm; at (*b*) and (*b*) the breathing is thoracic, and the aponeurosis remains on the same plane during inspiration and expiration.

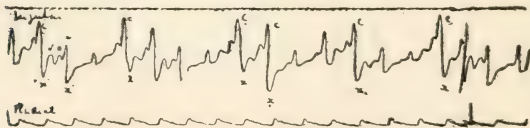
the contained blood column are exposed to the influence of intrathoracic and intrapericardial negative pressures, and the effect of these influences is registered in the deep deflections of the jugular respiratory curve. These deflections are made remarkable by the width and depth of the *x* and *y* depressions.

The Jugular Pulse and the beginning of Diastole.

Beginning of diastole.

THE fundamental principles of cardiology rest upon the teachings of physiology, and it is a matter of first importance to those who are engaged in the pursuit of Dr. James Mackenzie's method of investigation that the time of events occurring in the cardiac cycle be precisely determined. The situation of the deflexion representing the start of the diastolic period in the jugular curve is a matter upon which some differences of opinion have been expressed.

In my paper on "The Jugular Pulse," published in the *Lancet* of January 25th, 1913, p. 239, I fixed the starting place of diastole at the fundus of the *x* depression, but I have been taken to task since by certain correspondents who regard



The declivity of the *c* wave is noticed in the above curve as descending to the fundus of the *x* depression unattended by a dicrotic appendage. This act of *c* ends systole and diastole begins.

diastole as beginning later in the curve, and an opinion ^{Beginning of diastole.} appears to be prevalent that it commences as late as the end of the post-sphygmie period, and that its onset is marked by the declivity of the *v* wave.

The question can be decided only by an appeal to physiology. Diastole begins at the instant when ventricular muscle enter upon the phase of relaxation. Transition from a state of contraction to a state of relaxation is sudden, and its precise time of appearance in the cardiac cycle is determinable by reference to a scale of intraventricular pressures. Commencement of the diastolic period is noted by Starling as occurring at the instant of the closing of the semilunar and aortic valves,* but since the closure of these valves results from an initial fall in intraventricular pressure, diastole must begin earlier, and in Hürthle's diagram appearing in the same work, decline of intraventricular pressure is shown to begin one-thirtieth of a second before the closure of the valves. Consequently a point marking the commencement of diastole is situated a trifle to the left of the aortic notch in the carotoid curve, and one-tenth of a second later in the radial. In a diagram showing synchronised radial and jugular tracings, a vertical line drawn to cut through the arterial curve one-thirtieth of a second to the left of the aortic notch would strike the venous curve at the fundus of the *x* depression and in the part of it from which the base of the *v* wave is beginning to rise. This physiological survey confirms the statement on the subject made by me in "The Jugular Pulse."

* Physiology, Fig. 3, p. 214.

Beginning of
diastole.

Remarks in this paper in regard to the *c* wave have also received some criticism, but that perhaps is my own fault, as I had failed to mention the fact that the *c* wave is not a direct arterial impression, but an impression conducted from an arterial source by the venous column. That this is so, is plain because the deflexion representing *c* rises and falls with the venous column during respiratory movements. Whereas if the impression from the carotid or subclavian artery were made direct upon the tracing through the air of the receiver, the deflexion *c* would remain upon a stationary plane, independent of fluctuations in the level of the venous column.

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On the Aspiratory Function of the Heart*

THE heart is a pump and, like the mechanical pump, possesses aspiratory and propulsive powers. Aspiratory function of the heart.

—aspiratory power to draw supplies from pulmonary and systemic veins, and propulsive power to discharge the contents of its ventricles into pulmonary and systemic arteries. The heart works in a minus-pressure environment which at the height of inspiration registers 30 to 50 mm. Hg. and during expiration falls to half this measure. Since fluids flow in the direction of the least resistance a centripetal current of blood from pulmonary and systemic sources sets in towards the minus-pressure environment of the heart, filling the great tributary veins, the auricles, and the ventricles. Intrathoracic minus-pressure thus constitutes a potential aspiratory force which keeps the central venous system perpetually full of blood, and maintains this section of the circulation under favourable conditions for the action of the kinetic aspiratory function of the ventricles.

*Reprinted from the Lancet, May 9th, 1914.

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The kinetic aspiratory function is intermittent and exercises itself only during systole. When the cone of the heart contracts and expels the contents of the ventricles into pulmonary and systemic arteries it vacates a section of the pericardial sac, a space which is instantly filled by the head of the venous column entering and expanding the auricles—the advance movement being rendered imperative by the *vis a tergo* of atmospheric pressure exercised upon the contents of pulmonary and systemic veins lying at the foot of the venous column. The impetus of the moving column of venous blood transmitted to the cone of the heart is felt upon the thoracic wall; hence the quality of the apex beat affords a fair indication of the efficiency of the aspiratory function, a term which denotes and includes both the potential and the kinetic forces of aspiration.

The aspiratory function may be lowered by asthenic states of the myocardium or by reduction of the minus pressure of the environment. The latter event occurs when the fibrous stroma of the lungs loses its elasticity, when the musculature of the diaphragm and the thoracic wall becomes atonic, when intrapleural and intrapericardial effusions accumulate, and when pressure from the abdomen reduces the capacity of the thoracic cavity.

When aspiratory function is lowered certain phenomena occur. *Vis a tergo* of atmospheric pressure loses its potency, and intrathoracic venous circulation languishes. Diastole of the right ventricle and that of the auricles is sluggish, and the current in pulmonary capillary circulation is slow. Congestion

of the pulmonary stream and stasis in bronchiolar radicles display themselves in symptomatic expression by asthma and dyspnœa. High peripheral resistance in the pulmonary field leads to high tension in the right ventricle, which, unable to discharge its contents fully, becomes the receptacle of a residual accumulation of blood. The barrel chest of emphysema is the result of attempts made by inspiratory musculature to neutralise the untoward effects of minus-pressure insufficiency.

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Contrast circulatory conditions prevailing in states of low intrathoracic minus-pressure, as in emphysema, with those obtaining in the incipient stages of fibroid phthisis, when minus-pressure is high, owing to contraction occurring in the fibrous stroma of the lungs. In the latter instance the heart is small. Asthma and pulmonary congestion are almost unknown, and the freshness of the complexion as compared with the greyiness of the skin of the emphysemic is a matter of note. The falling in of the chest wall at later stages points to the existence of excessive degrees of minus-pressure. This condition is also apparent in the well defined deflexions of the jugular curve, which contrasts sharply with the featureless appearances of the jugular curve of the emphysemic.

In the recumbent posture, when the shoulders are depressed, the diaphragm seeks a high horizontal plane of activity; intrathoracic minus-pressure is correspondingly reduced and aspiratory function is lowered. Hence this posture is intolerable to the subject possessed of a weak aspiratory function. When the trunk is upright the liver,

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attached by its suspensory ligament to the aponeurosis of the diaphragm, seeks a lower situation in the abdominal cavity, drawing down with it the diaphragm, which now engages itself upon a deeper plane of action. For this reason the subject of a weak aspiratory function even during the hours of sleep assumes an upright pose. When the aspiratory function is excessively low the patient stands up, resting and fixing his arms and bent shoulders over some object of support. He thus secures a depending liver, and at the same time obtains a *point d'appui* from which inspiratory muscles attached to the thoracic wall may exercise themselves with effect. By this means the fullest measure of intrathoracic minus-pressure is secured.

To speak of the limitation of the movements of the heart through the direct effects of abdominal pressure is incorrect. The heart is suspended in a bony cage, and the arching of the diaphragm is limited by unyielding aponeurotic structures. Thus when the diaphragm has attained its highest plane of elevation ample room remains for the heart to disport itself without let or hindrance. Nevertheless the heart is affected by intragastric and intra-abdominal hyper-pressure—the one condition determining sympathetic acceleration or vagal inhibition, the other inefficiency of the aspiratory function.

The object of this paper is to draw the attention of the practitioner of medicine to a subject of clinical importance, and one having a bearing upon treatment—a subject which has suffered strange neglect at the hands of the cardiologist.

Upon turning over the pages of several recent works upon Aspiratory
heart disease I have not found so far even bare mention of function of
the heart.
the subject.

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On the Segmentary Neurosis in Appendicitis.*

Segmentary
neurosis in
appendicitis.

I NOTICE in the *Lancet* of June 13th a letter by Mr. H. J. Paterson which attacks Sir George T. Beatson for his conservatism and lays down the rule that operation in appendicitis should in every case be performed as soon as possible—that is to say, “in the first forty-eight hours.” I suggest that Mr. Paterson has overlooked the frequency of the occurrence of the incipient appendicitis and the readiness with which appendicitis in its earlier stages yields to medical treatment. Among families attended by me through a course of years there are few which do not include members who have suffered from appendicitis. Yet in my practice the operation for this complaint has been a rare incident. In a period of thirty years’ duration, operations have numbered no more than four or five. Nevertheless, with cases so numerous and with operations so few, no death has occurred from the complaint or from its sequelæ. In the class of cases I attend I have the advantage of seeing a patient at the beginning of his illness.

*Reprinted from the *Lancet*, June 27th, 1914.

Let me emphasise this fact. Treatment followed in every case has been after the method employed universally years ago. It was formerly regarded as among the rudiments of treatment that the processes of resolution of intestinal lesions should be allowed a fair field for their activities, and this end was attained by the administration of drugs such as opium and hyoscyamus, which reduce spasm and minister to a restful state of the parts. This method, although now regarded as mischievous, is nevertheless based upon a true conception of the nature of the complaint, a conception which seems to have been forgotten. Uncomplicated incipient appendicitis possesses no pathognomonic symptoms. A foreign body may retain lodgment in the lumen of the appendix, yet no symptoms significant of its presence appear. Inflammation limited to the intestinal wall causes no pain. Ulceration may even be present, and yet signs of perforation be the first intimation of its existence.

The symptoms recognised as those of the appendicitis are in truth those of complications of the appendicitis—namely, the central nervous and the peritoneal. The complication, which usually first attracts attention to the complaint, is a state of irritability of the central nervous system. A segmentary reflex neurosis affecting the ninth and tenth sections of the thoracic cord is called into being by irritative impressions directed from the intestinal wall. Since the ninth and tenth thoracic sections innervate the bowel in that part of its course which lies between the pyloric vestibule and the cæcum the segmentary reflex neurosis found complicating

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the appendicitis may arise from sources of irritation far removed from the appendix, and thus it constitutes a pregnant source of error in the matter of differential diagnosis as between lesions of the duodenum, gall-bladder, and appendix. Symptoms of the neurosis are rigidity and spasm of parietal and visceral sheets of muscle. The right rectus abdominis muscle is hard and lumpish. The ileo-cæcal sphincter and the pyloric vestibule are seats of spasm. Gas and fæces are held up in the intestines, and vomiting is a frequent incident. Algesia is present, pain is felt, and exacerbation of pain occurs when intra-intestinal pressure is raised by peristalsis.

Sometimes sections of the cord, involved in the neurosis, are affected bilaterally, and then manifestations of algesia, pain, and rigidity appear upon the left side of the median line as well as upon the right side. A healthy abdominal cavity may now fall under suspicion as the seat of diffuse peritonitis. The advent of the segmentary reflex neurosis upon the scene introduces a new danger. The blood supply of the appendix is controlled by sections of the cord implicated in the neurosis and the organ is dependent for its nutrition upon the integrity of a single artery. Under a vaso-constrictor impulse, exaggerated by the irritable state of the centre, total extinction of arterial supply may occur and then necrosis results. Under these circumstances delay in the reduction of the neurosis invites disaster and in view of this contingency the policy of the administration of opium receives abundant defence. When this precaution has been taken, delay in the matter of operation loses its chief danger.

In no type of disease is the beneficial effect of opium shown to better advantage than in appendicitis. Within a few hours the entire aspect of the case undergoes change. Pyloric spasm relaxes, and retching, eructation of flatus, and vomiting cease. The ileo-cæcal sphincter no longer holds up gas and faeces; peristalsis is stayed, intestinal tension falls, and pain declines. Administrations of opium reduce rigidity and algæa of the abdominal wall. Symptoms which mask are removed, and symptoms which matter are allowed to manifest themselves. Unless the dose be excessive peritoneal algæa remains unaffected by it. Visceral structures constituting the contents of the abdominal cavity now lie in a field open for clinical investigation. The outline of the hyperplastic tumour may be defined, and patches of localised peritonitis detected. Under continued administration of opium these last traces of appendiceal complication soon disappear. In my experience recurrence of the disorder is not frequent, although in certain cases I have known secondary and tertiary outbreaks to occur. These I attribute to shortness of the period during which the patient had remained under treatment, a sufficiency of time not having been allowed for resolution of the original lesion.

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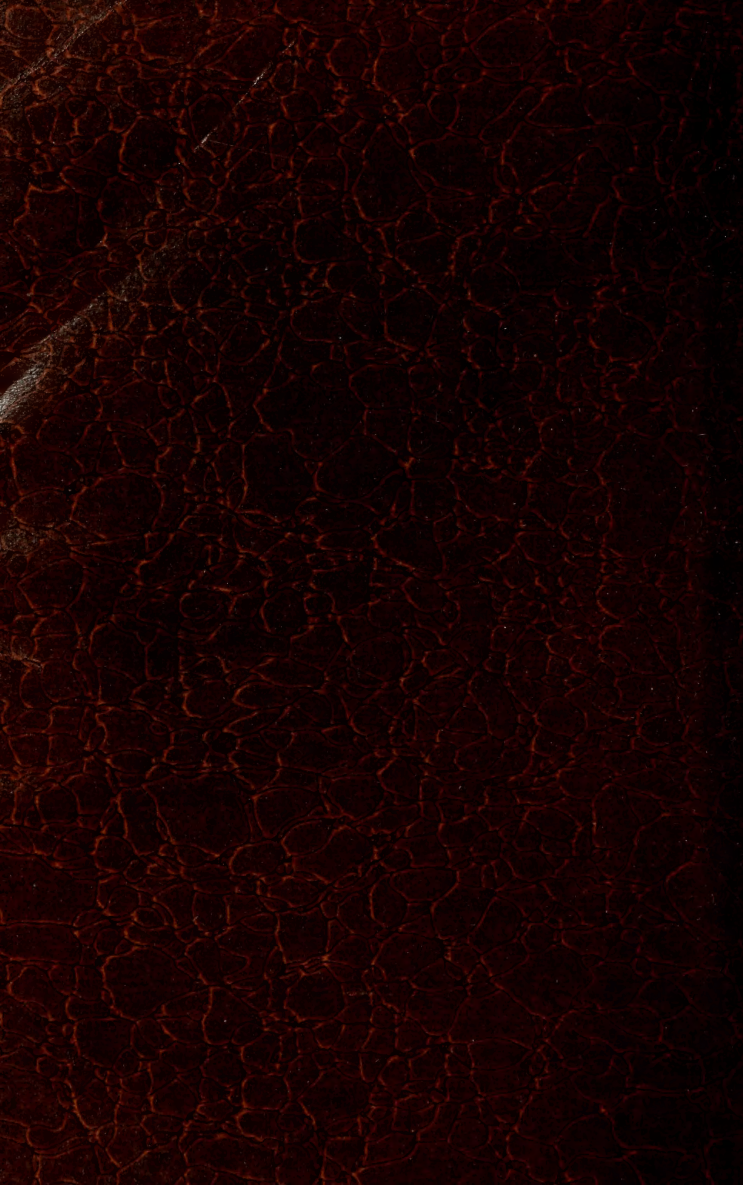
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